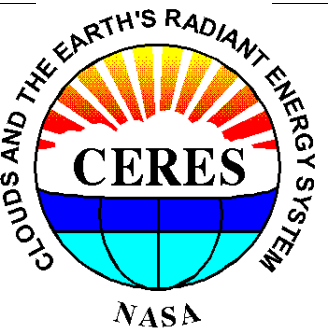
CERES Instrument Cal/Val Report

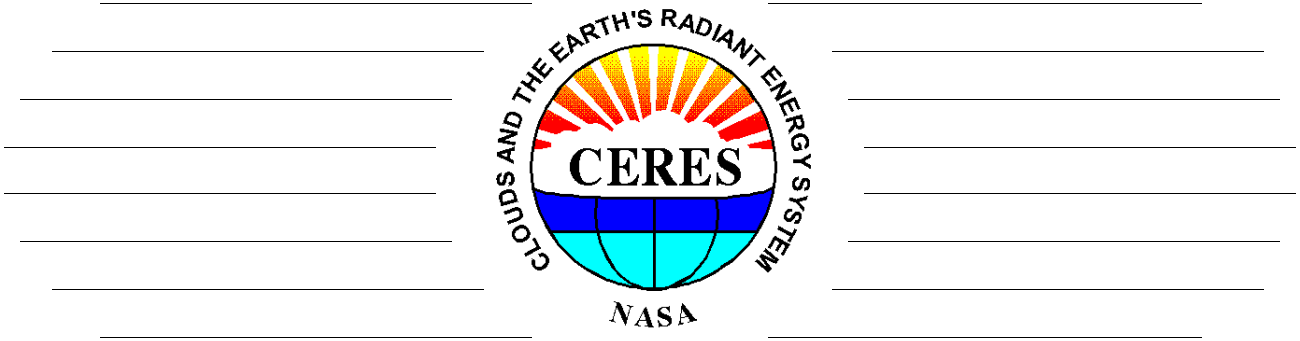


Kory J. Priestley
Robert Lee, Susan Thomas,Aiman Al-Hajjah,
Robert Wilson, Pete Spence, Ed Kizer, Peter Szewczyk
Phil Hess, Joey Escuadra, Denise Cooper, Dale Walikainen,
Mike Cisewski, Bill Vogler, Jim Bailey

28th CERES Science Team Meeting
Norfolk, VA

NASA Langley Research Center
Atmospheric SCIENCES

CERES DSCAL #1 Preliminary Report

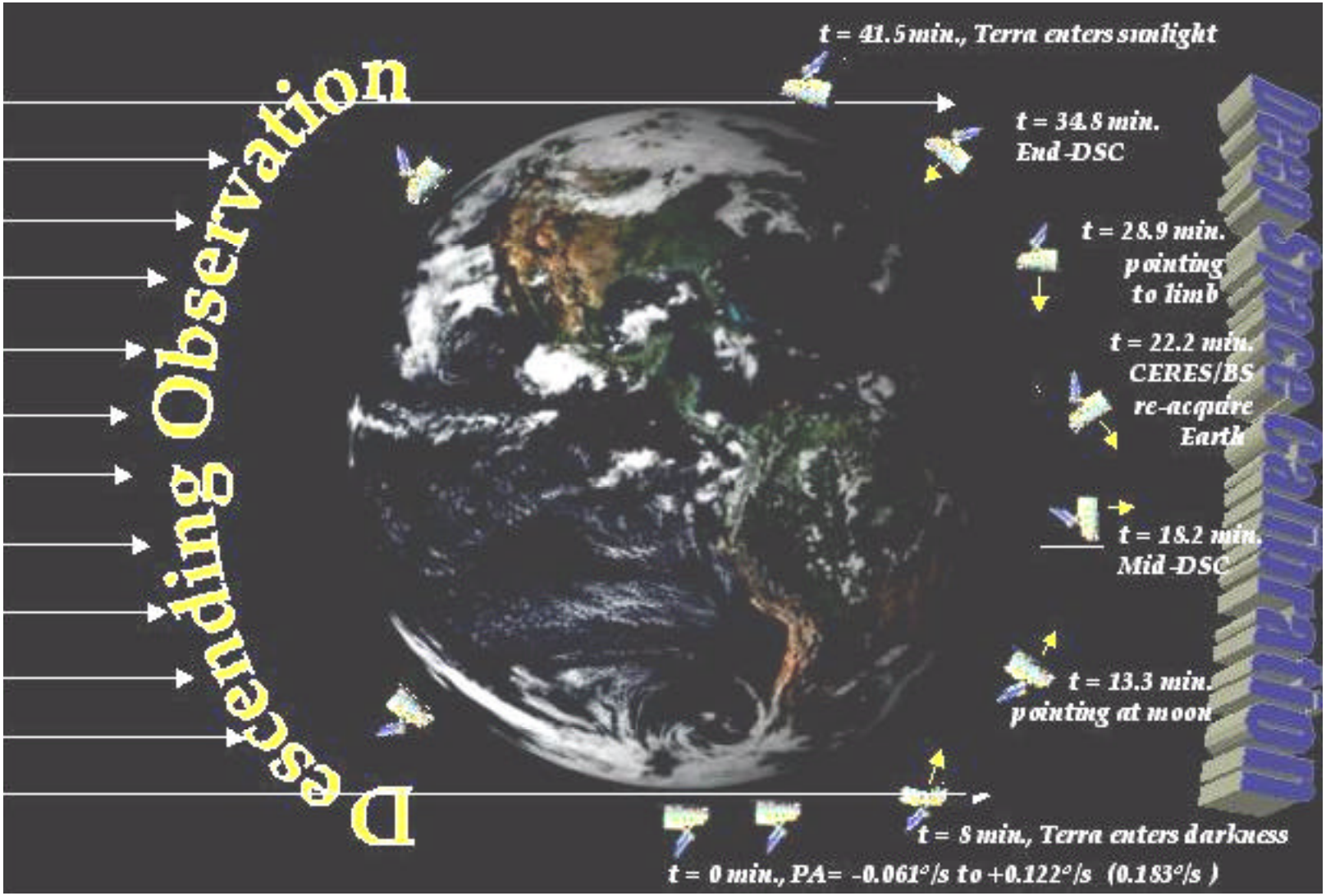


Instrument Working Group & FOT

May 6, 2003

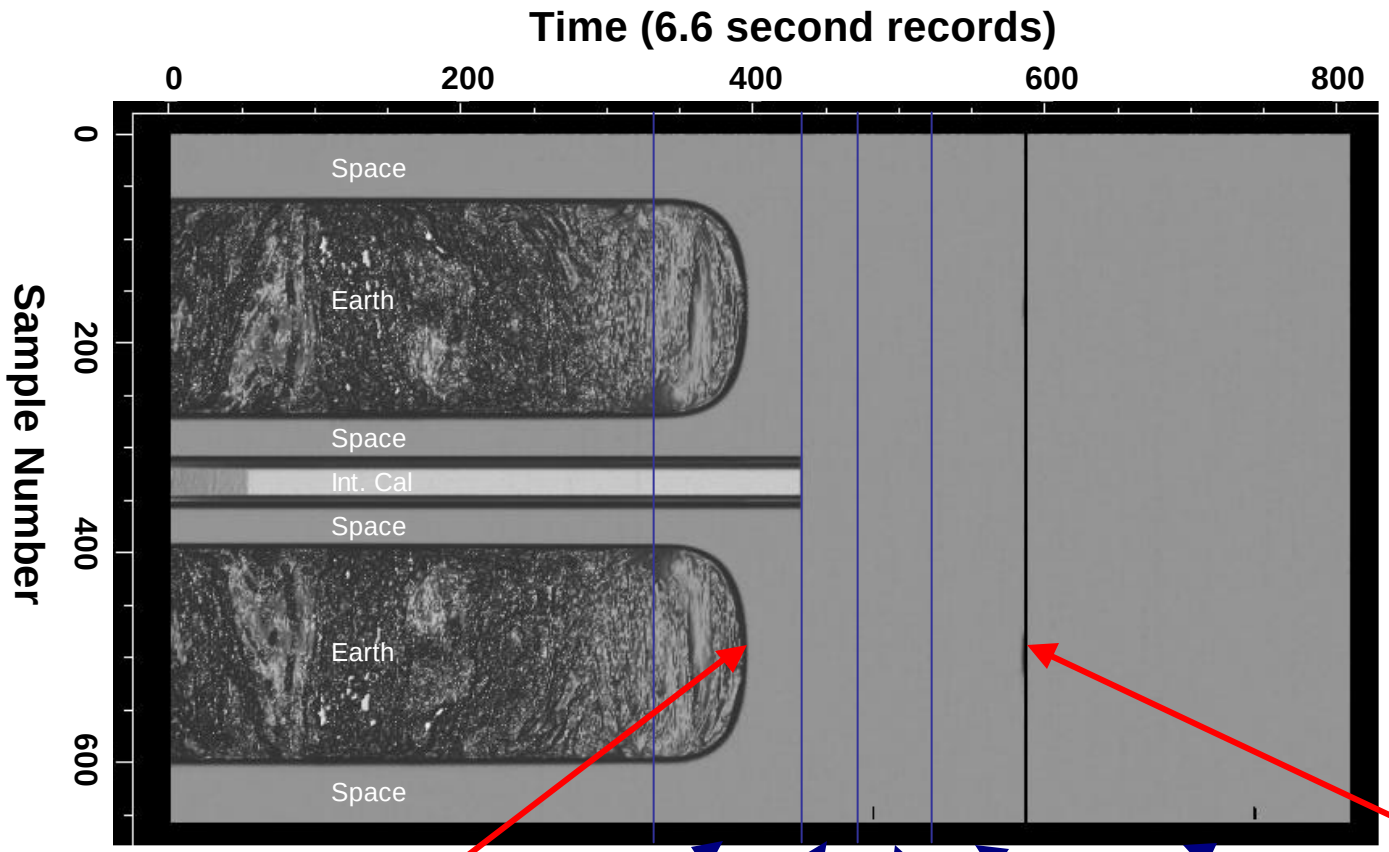
NASA Langley Research Center
Atmospheric SCIENCES

Deep Space Cal Key Events and Timing



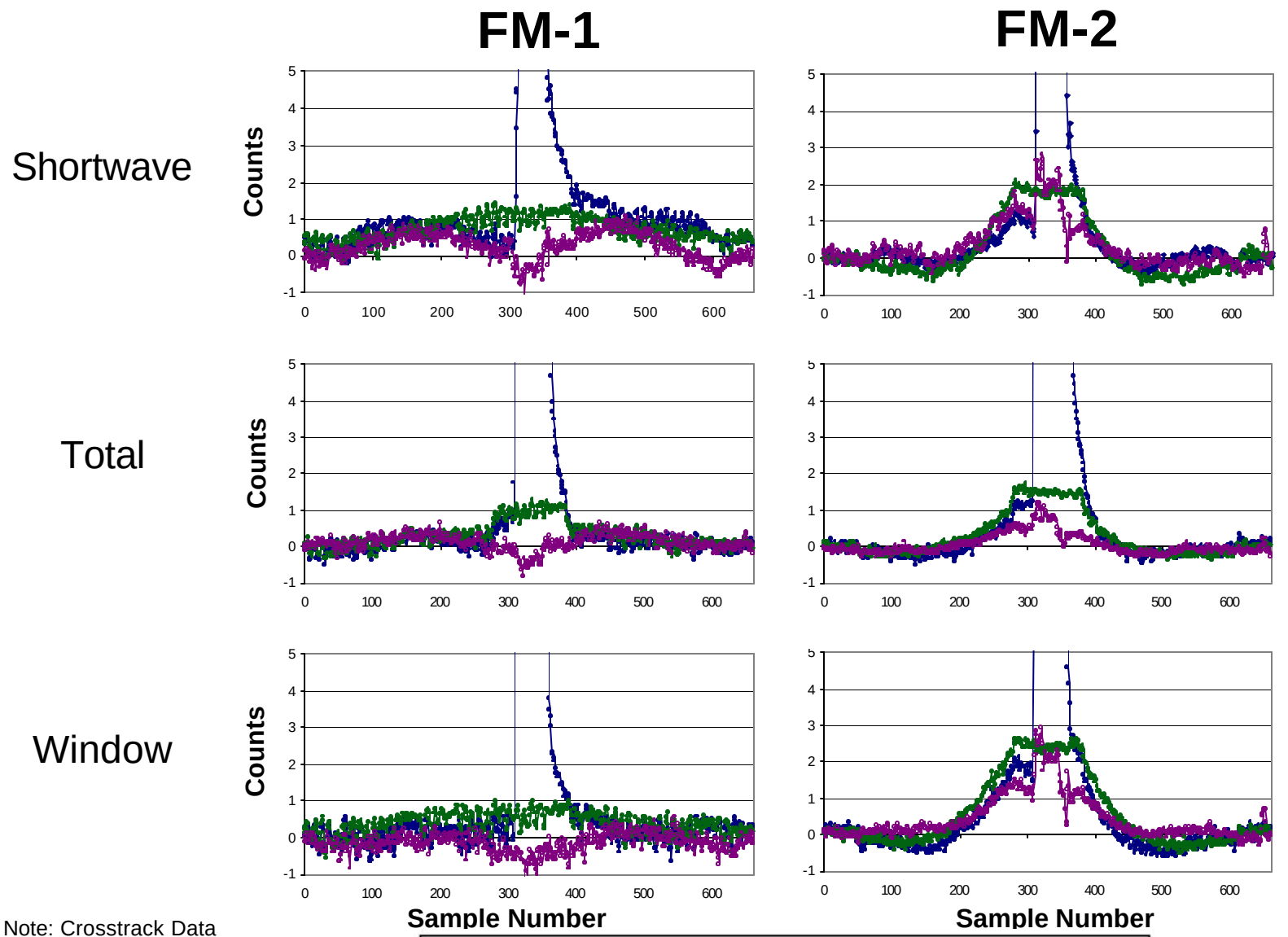
CERES DSCal Science Data Collected

Flight Model 1, Total Channel



Elevation:	Normal	Short	Normal no-cal	Normal no-cal	Stowed
Azimuth:	Crosstrack	Crosstrack	Rotating	Crosstrack	Crosstrack
# of Records:	34	31	55	65	

Ground Vs. Flight: Scan Dependent Offsets

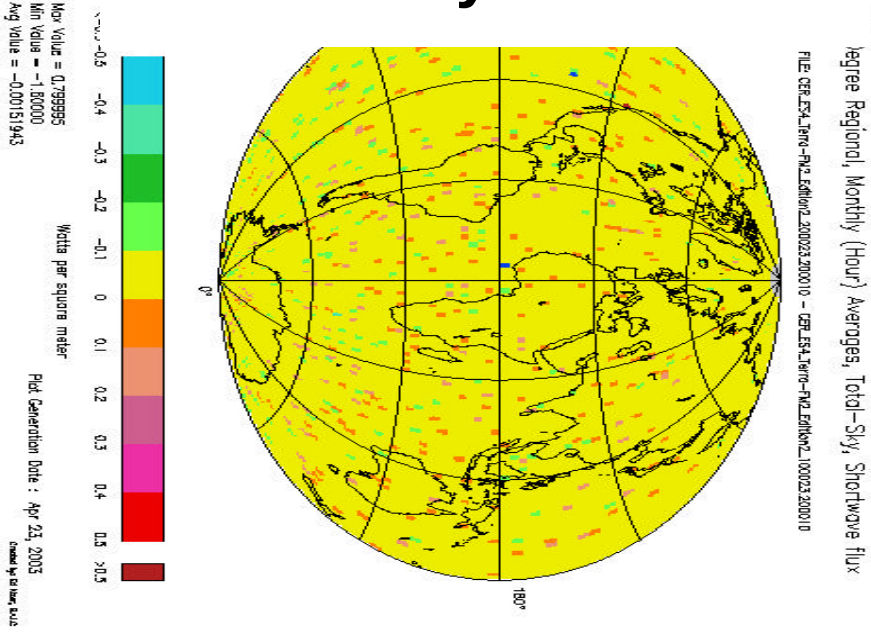


Note: Crosstrack Data Samples 58-279 and 388-609 are Earth-viewing

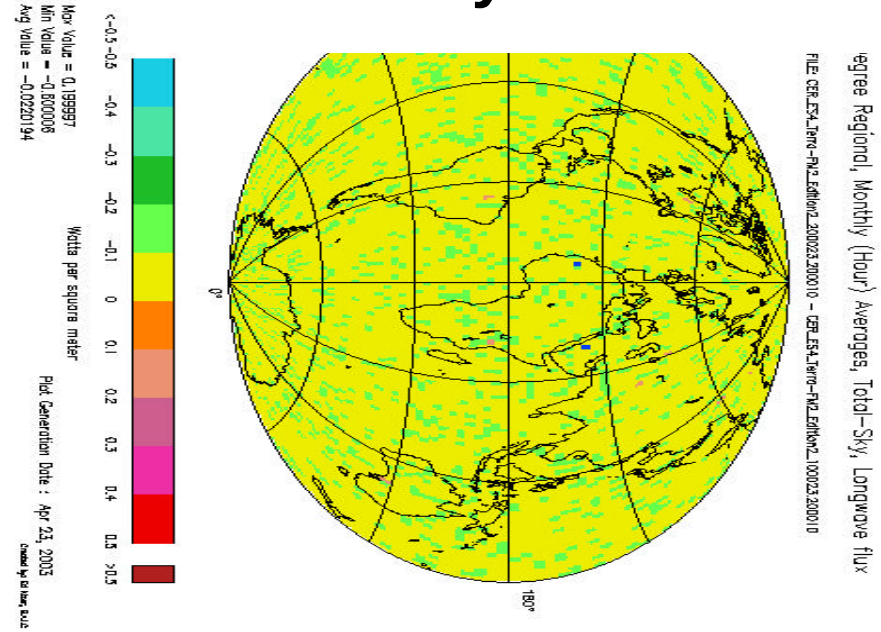
Ground Vs. Flight Offsets : Impacts

Terra FM2 ES4 Data for October, 2000

Total-Sky SW Flux



Total-Sky LW Flux



CERES DSCAL Initial Results

- CERES DSCal Sequence executed flawlessly…science data analysis continuing

- Minimal changes from pre-launch measurements of scan angle dependent offsets
  - ~0.5 counts or 0.25 W/m^2 SW flux, 0.5W/m^2 Daytime LW flux
- First measurements of offsets for the biaxial scan mode completed
  - Biaxial offset measurements require zero-G environment
- Primary benefit of maneuvers 2 & 3 will be collection of additional biaxial data.
  - DSCal design allows only 5 independent biaxial samples per maneuver
  - Desire minimum of 10 samples to approach climate accuracy requirements
- Percent of desired data collected:
  - 1 maneuver ~65%
  - 2 maneuvers ~85%
  - 3 maneuvers ~95%
- CERES Biaxial scanning spans 6 minute period centered at midpoint of maneuver
  - Remainder of maneuver is crosstrack for CERES
- Waiting for direction from GSFC regarding jitter analysis and impact to Modis and MISR during lunar views in DSCal #2.

INSTRUMENT WORKING GROUP

CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM

Introduction | Activities | Documentation | Operations | Production | Data | Personnel

ACTIVITIES

Choose from one of the links below:

Ground Calibration

Deep Space Calibration

Validation

Field Campaigns:

CLAMS CRYSTAL-FACE INDOEX
LaRC-ULDB GERB Aerosols
Terra/Aqua Intercalibration
Solar Principal Plane Scans (PPS)

Event Calendar: 2003

NASA LaRC

Last Updated: Tue Apr 29 13:03:55 2003
Web Curator: Phil Hess (p.c.hess@larc.nasa.gov)
Responsible NASA Official: Kory Priestley (k.j.priestley@larc.nasa.gov)

CERES Home Page

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http://asd-www.larc.nasa.gov/Instrument/

NASA LaRC

Last Updated: Tue Apr 29 13:03:55 2003
Web Curator: Phil Hess (p.c.hess@larc.nasa.gov)
Responsible NASA Official: Kory Priestley (k.j.priestley@larc.nasa.gov)

CERES Home Page

Instrument Operations

MAY						
SUN	MON	TUE	WED	THU	FRI	SAT
				5/1 [121] FM4: PPS FM3:BX=>XT FM4:XT=>BX FM1-4: Diagnostics	5/2 [122] FM4: PPS BB IntCal	5/3 [123] FM4: PPS
5/4 [124] FM4: PPS FM2: Aerosols	5/5 [125] FM4: PPS FM2: Aerosols BB IntCal	5/6 [126] FM4: PPS FM2: Aerosols CERES Science Team Meeting	5/7 [127] FM4: PPS FM2: Aerosols FM2: GERB Test IntCal CERES Science Team Meeting	5/8 [128] FM4: PPS FM2: Aerosols FM2: GERB Test CERES Science Team Meeting	5/9 [129] FM2: Aerosols BB IntCal	5/10 [130] FM2: Aerosols
5/11 [131] FM2: Aerosols	5/12 [132] FM2: Aerosols BB IntCal	5/13 [133] FM2: Aerosols	5/14 [134] FM2: Aerosols Solcal/IntCal	5/15 [135] FM2: Aerosols	5/16 [136] FM2: Aerosols FM1-4: Lunar Eclipse BB IntCal	5/17 [137] FM2: Aerosols
5/18 [138] FM2: Aerosols	5/19 [139] FM2: Aerosols BB IntCal	5/20 [140] FM2: Aerosols	5/21 [141] FM2: Aerosols IntCal	5/22 [142] FM2: Aerosols	5/23 [143] FM2: Aerosols BB IntCal	5/24 [144] FM2: Aerosols
5/25 [145] FM2: Aerosols	5/26 [146] FM2: GERB FM2: Aerosols BB IntCal Holiday	5/27 [147] FM2: GERB FM2: Aerosols	5/28 [148] FM2: GERB FM2: Aerosols Solcal/IntCal	5/29 [149] FM2: GERB FM2: Aerosols	5/30 [150] FM2: GERB FM2: Aerosols BB IntCal	5/31 [151] FM2: GERB FM2: Aerosols

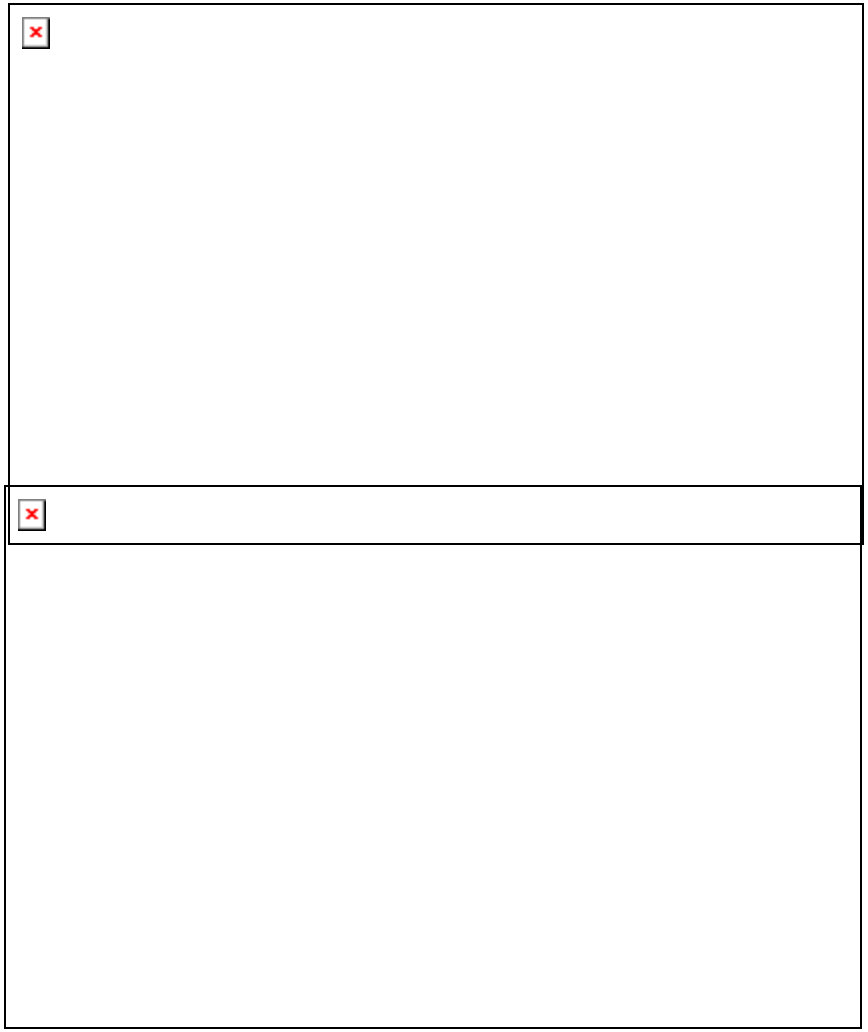
Instrument Operations

JUNE						
SUN	MON	TUE	WED	THU	FRI	SAT
6/1 [152] FM2: GERB	6/2 [153] FM2: GERB BB IntCal	6/3 [154] FM2: GERB	6/4 [155] FM2: GERB IntCal	6/5 [156] FM2: GERB	6/6 [157] FM2: GERB BB IntCal	6/7 [158] FM2: GERB
6/8 [159] FM1/4: Greenland	6/9 [160] FM1/4: Greenland BB IntCal	6/10 [161] FM1/4: Greenland	6/11 [162] FM1/4: Greenland Solcal/IntCal	6/12 [163] FM1/4: Greenland FM1-4: Lunar Phase	6/13 [164] FM1/4: Greenland FM1-4: Lunar Phase BB IntCal	6/14 [165] FM1/4: Greenland FM1-4: Lunar Phase Terra: DSC#3?
6/15 [166] FM1/4: Greenland FM1-4: Lunar Phase	6/16 [167] FM1/4: Greenland FM1-4: Lunar Phase BB IntCal	6/17 [168] FM1/4: Greenland	6/18 [169] FM1/4: Greenland IntCal	6/19 [170] FM1/4: Greenland	6/20 [171] FM1/4: Greenland BB IntCal	6/21 [172] FM1/4: Greenland
6/22 [173]	6/23 [174] BB IntCal	6/24 [175]	6/25 [176] Solcal/IntCal	6/26 [177]	6/27 [178] BB IntCal	6/28 [179]
6/29 [180]	6/30 [181] BB IntCal					

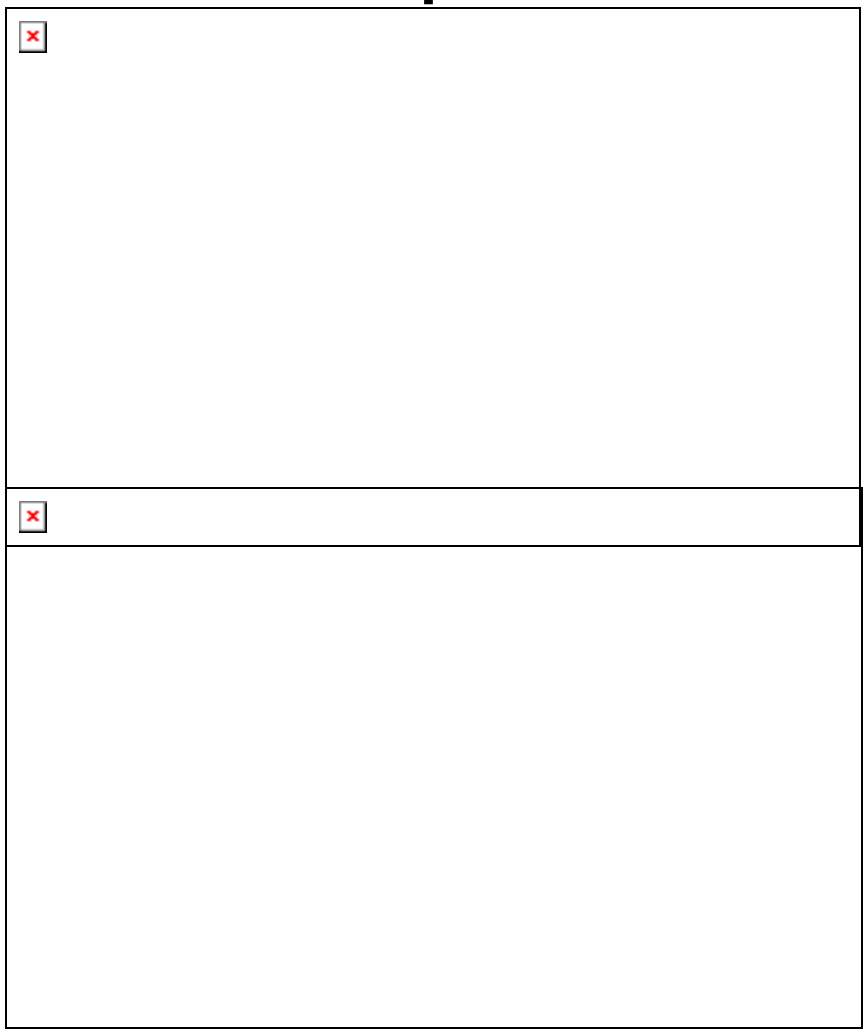
Pointing Knowledge

Coastline Detection

Terra



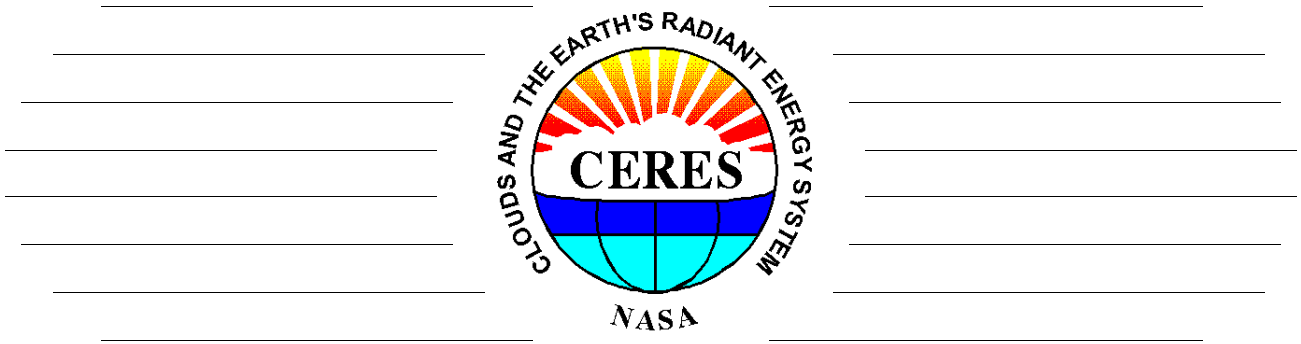
Aqua



BDS and ERBE-Like Product Status

Spacecraft	Product	Version	Available	Months Processed
Terra	BDS	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 12/02
	ERBE-like	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 12/02
Aqua	BDS	Edition1	Yes	6/02 - present
	ERBE-like	Beta2	Yes	6/02 - 12/02
		Edition1	6/03	7/02 & 8/02

Terra Status Report



Instrument Working Group

May 6, 2003

NASA Langley Research Center
Atmospheric SCIENCES

Edition2 BDS and ERBE-Like Products: Drift Removal Methodology

Drifts are modeled as originating from either of 2 physical entities…..

- **Radiometric Gain Change**
  - **Wavelength independent change in sensor responsivity**
  - **Corrections implemented in Count Conversion algorithm (SS1)**

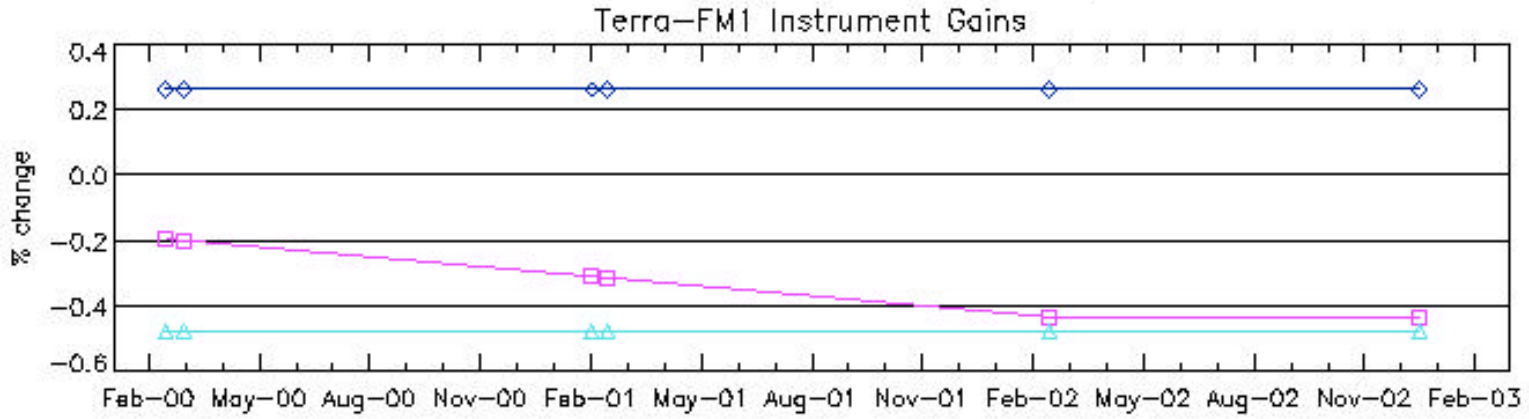
- **Spectral Response Change**
  - **Wavelength dependent change in sensor absorptivity**
  - **Corrections implemented in Spectral Unfiltering algorithms (SS2)**

- **Updated Radiometric Gains and Spectral Response Functions will be generated on a monthly basis and will be implemented on either a daily (Gains) or monthly (Spectral) interpolated basis.**

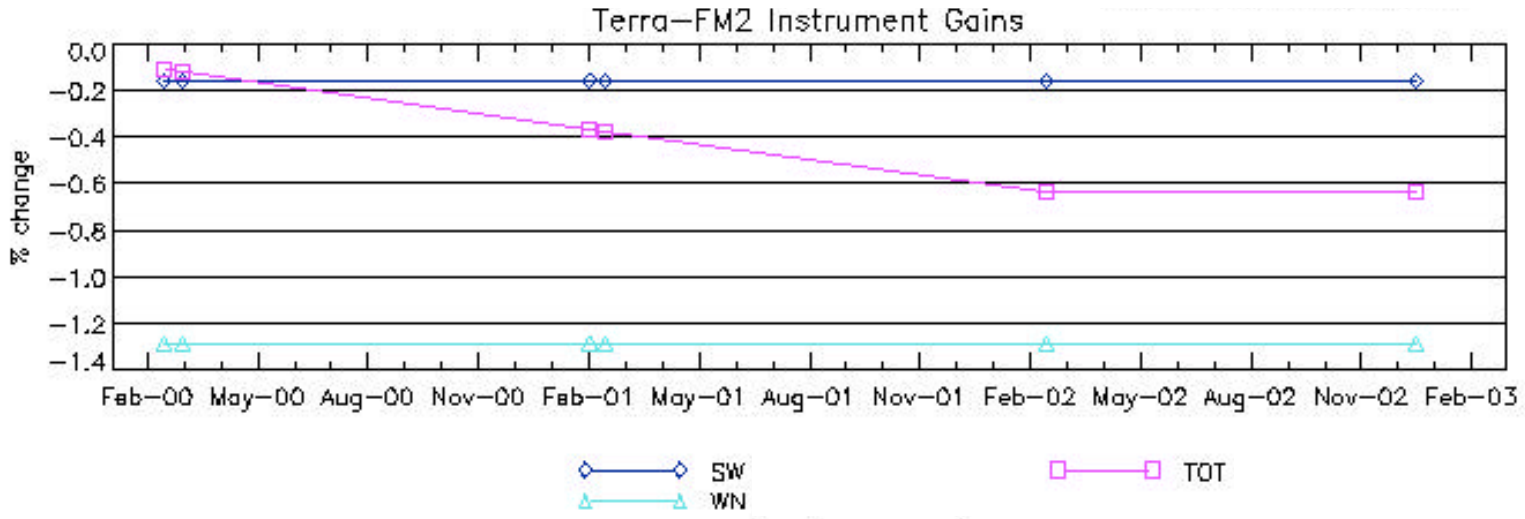
Instrument Group has delivered corrections for the first 34 months of Terra data. Testing is still occuring for Jan-03 to present.

Terra BDS Edition 2 Changes

By Channel and Date

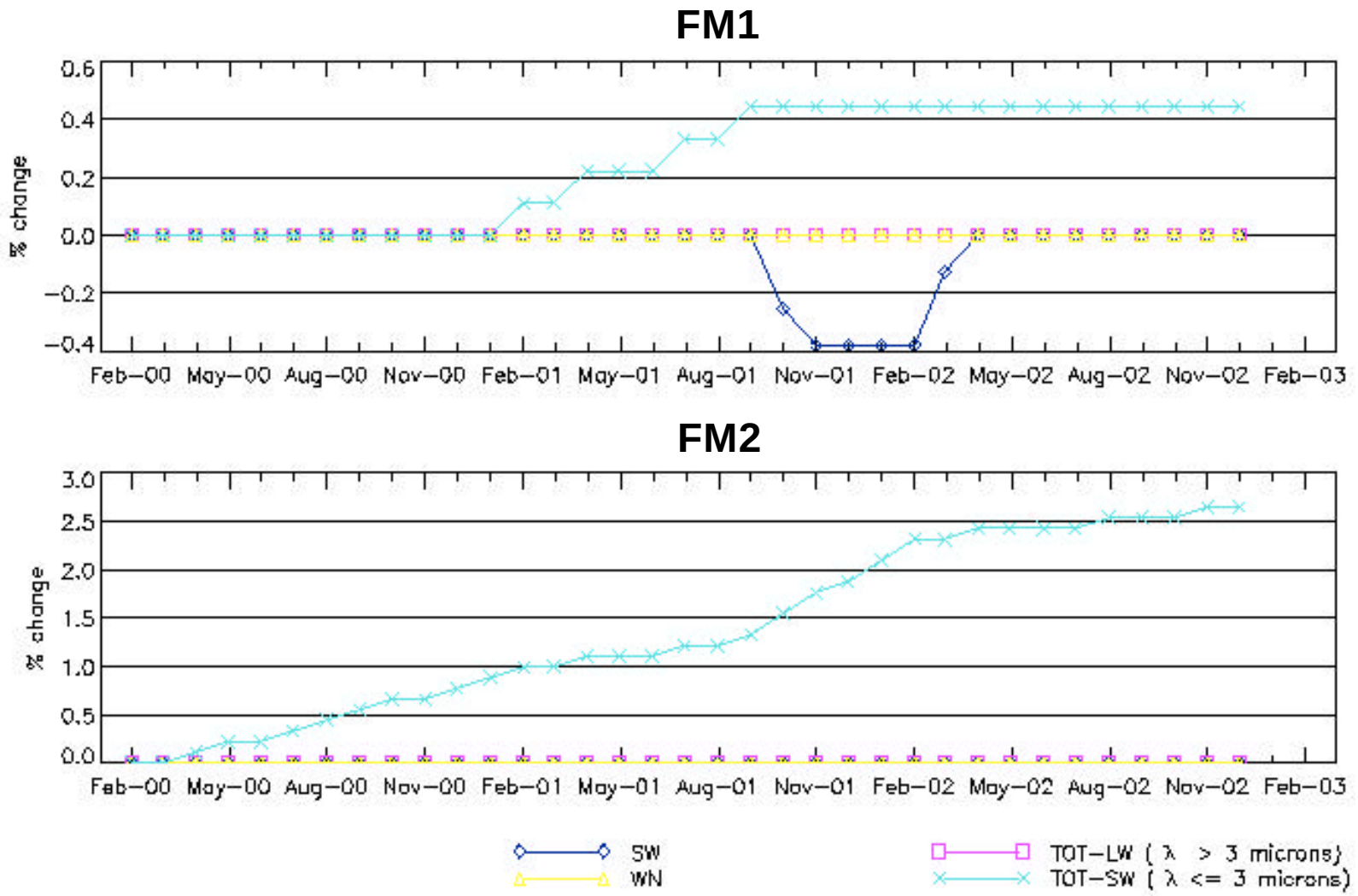


Normalized to Ground Calibration Data



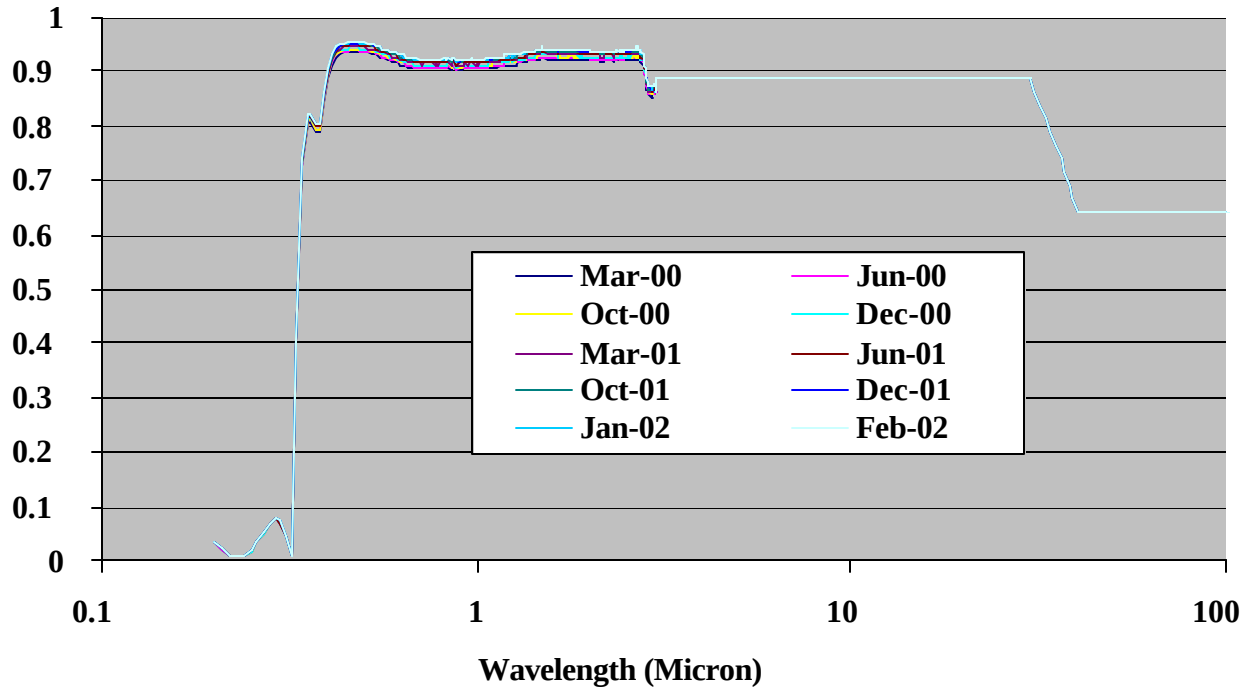
Terra ERBE-Like Edition 2 Changes

Spectral Response Function % change

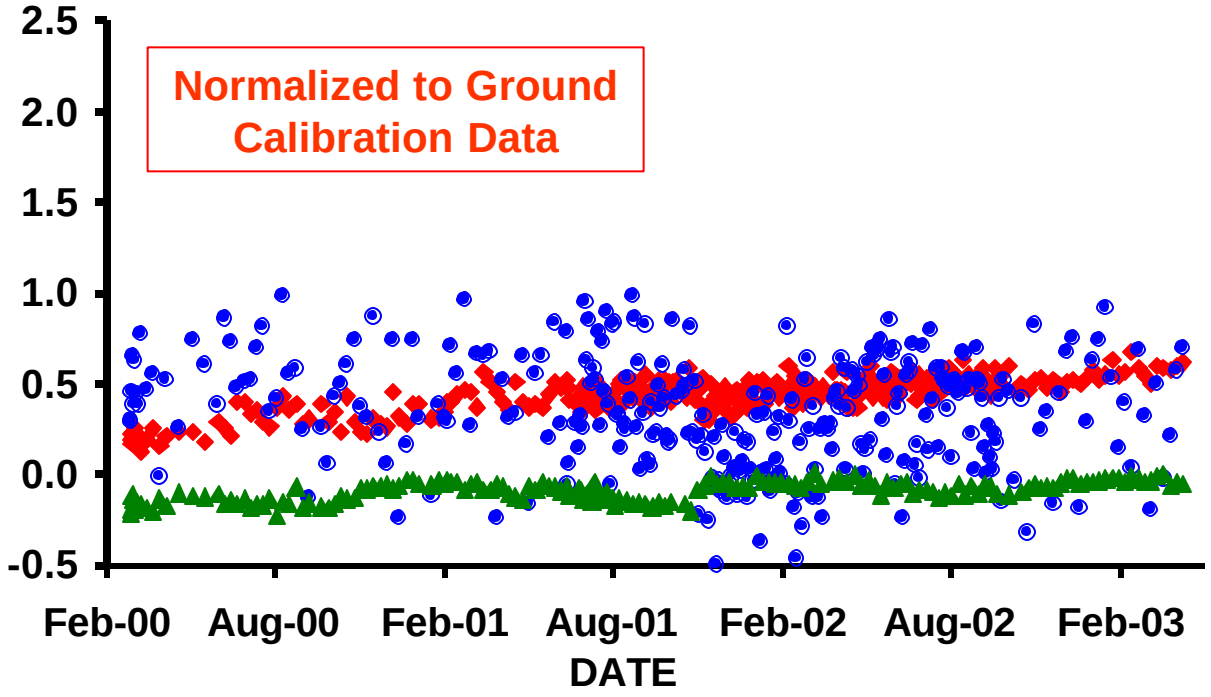


Edition 2 BDS and ERBE-Like Products: Results

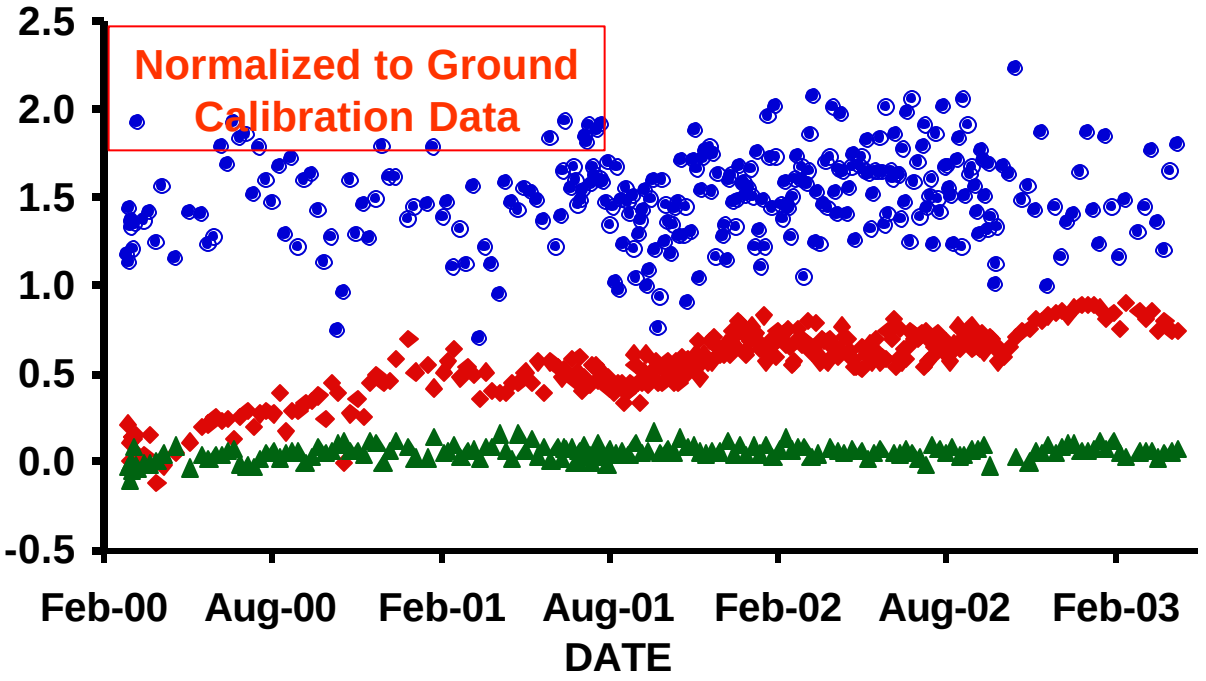
- **Spectral Response Change**
  - **Modeled as a gray increase in the spectral throughput of the SW portion of the FM-2 Total channel (i.e. 0.2 - 3.0 microns) over the first34 months of data collected.**



Terra/Flight Model 1
Lifetime Radiometric Stability
Determined with the Internal Calibration Module

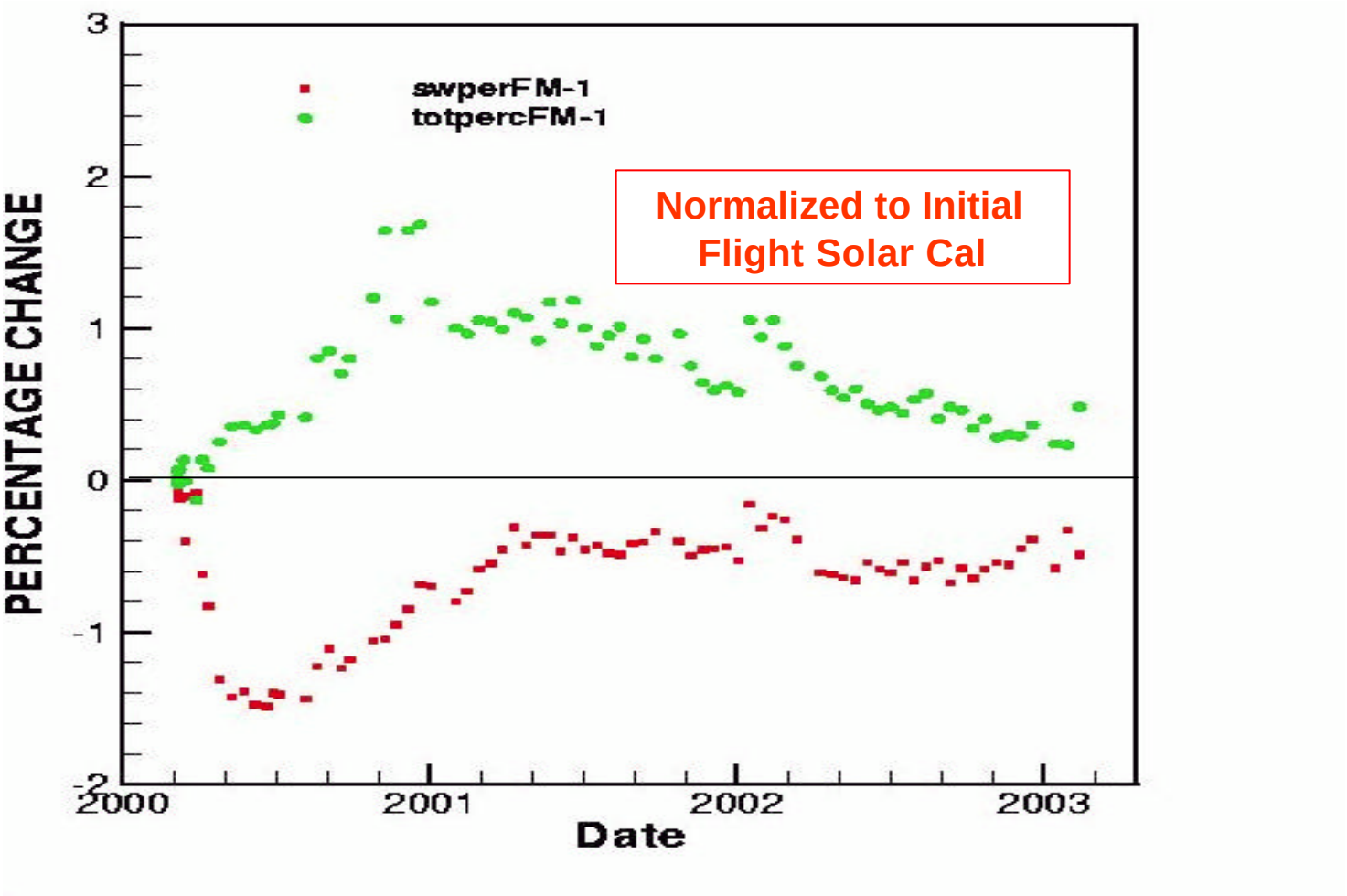


Terra/Flight Model 2
Lifetime Radiometric Stability
Determined with the Internal Calibration Module



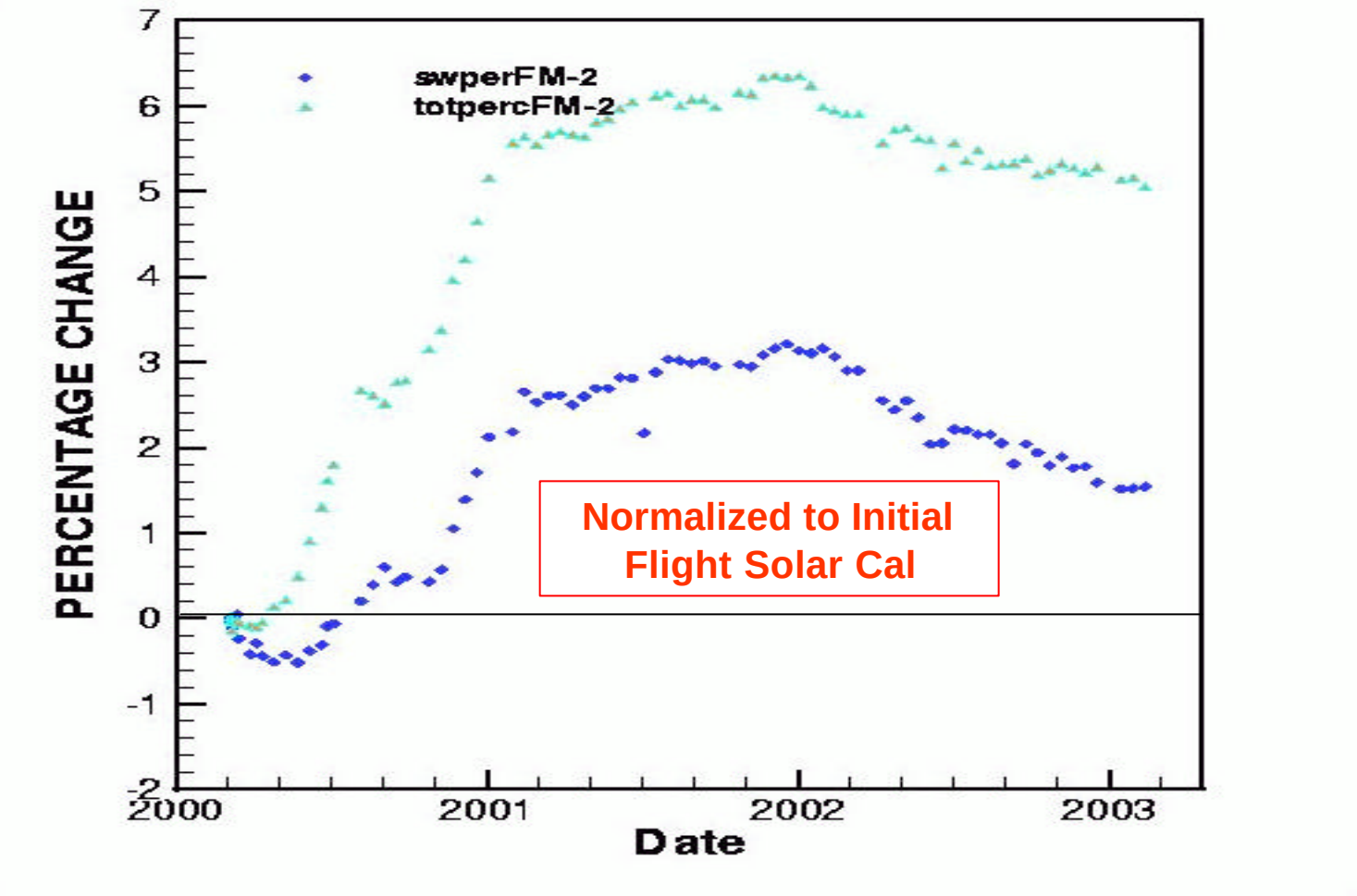
Terra/Flight Model 1
On-Orbit Radiometric Stability

Determined with the Mirror Attenuator Mosaic (MAM)



Terra/Flight Model 2
On-Orbit Radiometric Stability

Determined with the Mirror Attenuator Mosaic (MAM)



Terra Edition 2 BDS and ERBE-Like Summary

3/00 - 2/01

Actions

Updated initial flight gains to account for shifts during launch.

Accounted for on-orbit drifts in detector responsivites, or gains.

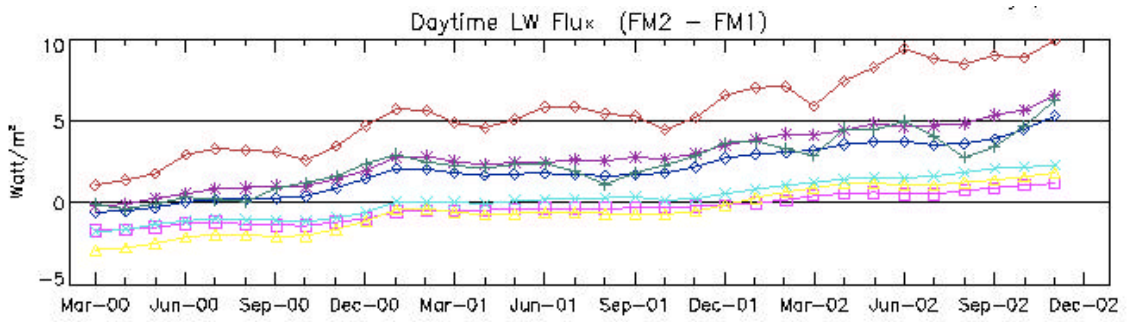
Accounted for changes in spectral coloration of the SW/TOT channels

Results (for All-Sky cases, 3/00 - 12/02)

		LW$_{day}$		LW$_{night}$		SW		WN$_{day}$		WN$_{night}$	
		Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1
Stability	**W/m^2**	**<.5**	**2.5**	**-**	**-**	**0.1**	**0.5**	**-**	**-**	**-**	**-**
	%	**<.2**	**1.0**	**-**	**-**	**<.1**	**.25**	**-**	**-**	**-**	**-**
Bias	**W/m^2**	**<1**	*******	**.5**	**.8**	**<.1**	**1.0**	**.01**	**.06**	**.01**	**.05**
	%	**<.5**	*******	**<.2**	**<.4**	**<.1**	**.25**	**0.2**	**1.0**	**0.2**	**1.0**

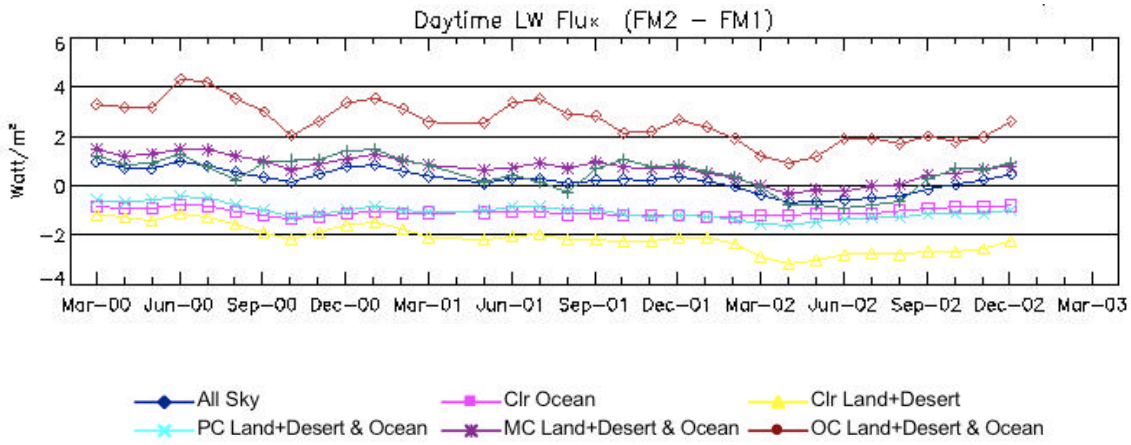
Terra Direct Comparison

Daytime LW Flux



Edition 1

Currently in Archive



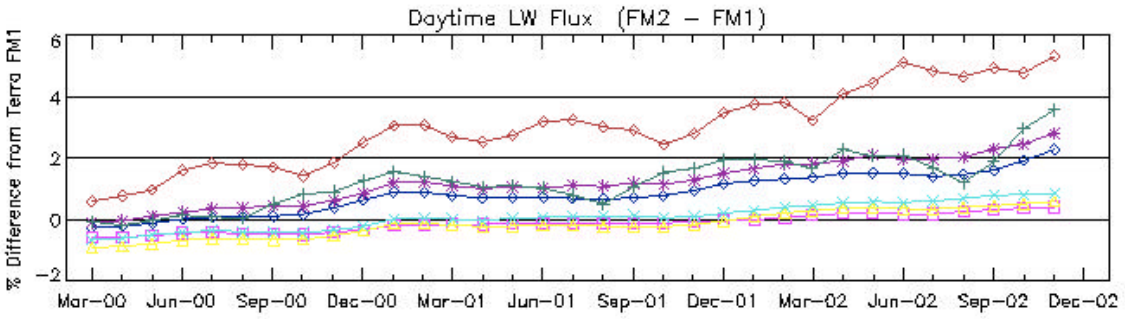
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

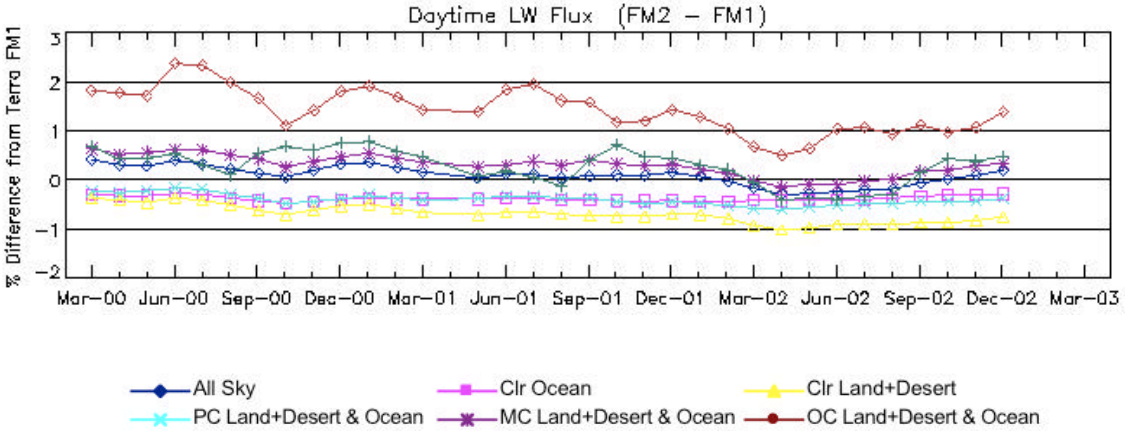
Terra Direct Comparison

Daytime LW Flux % Difference



Edition 1

Currently in Archive



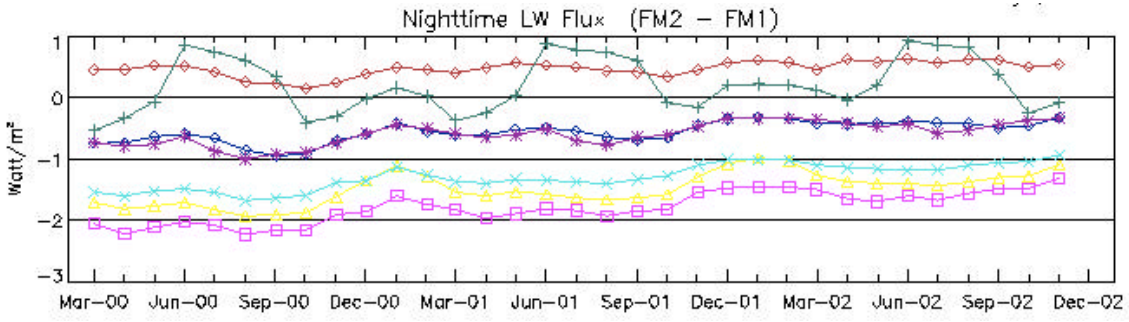
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

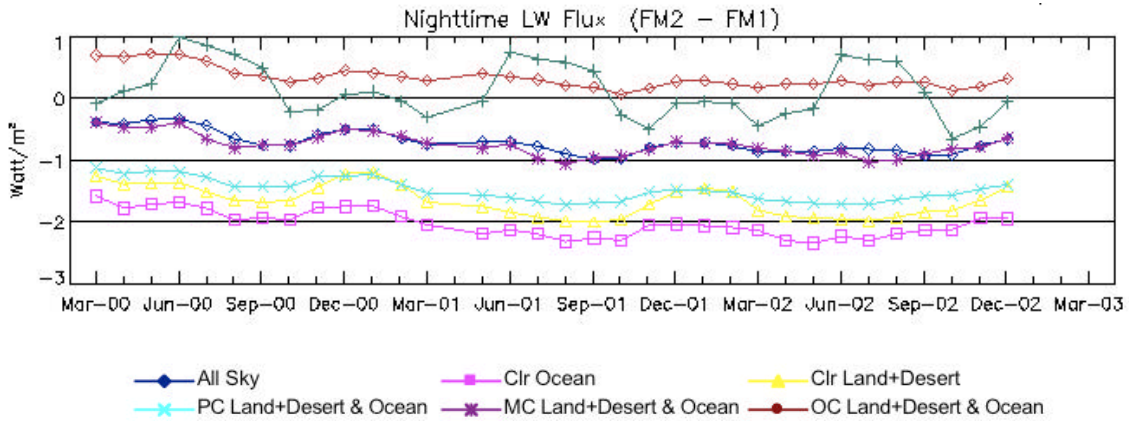
Terra Direct Comparison

Nighttime LW Flux



Edition 1

Currently in Archive



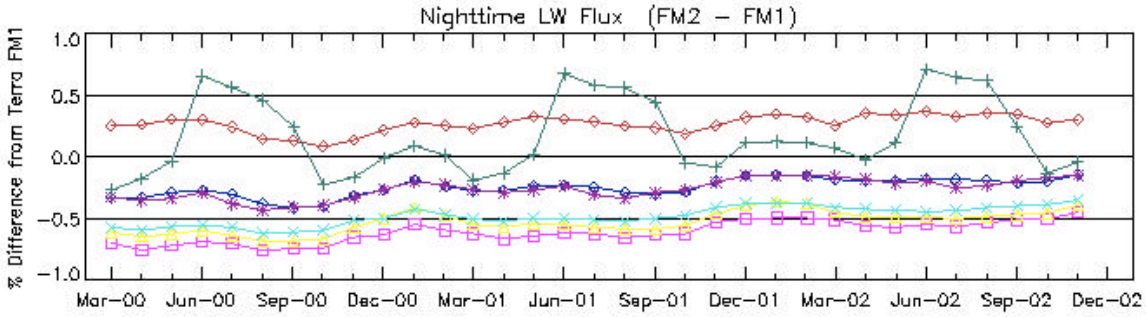
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

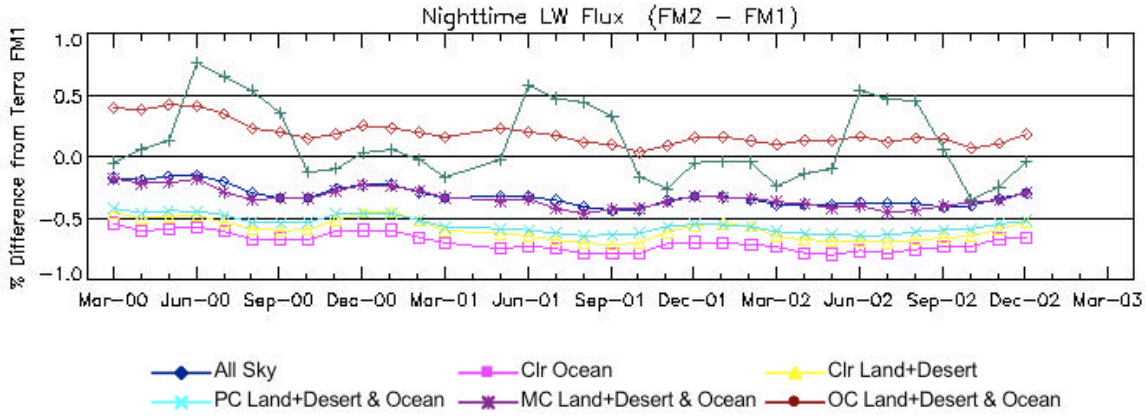
Terra Direct Comparison

Nighttime LW Flux % Difference



Edition 1

Currently in Archive



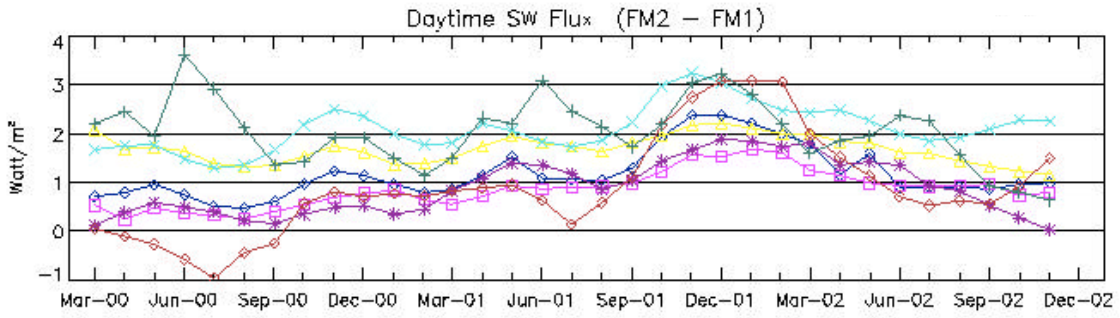
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

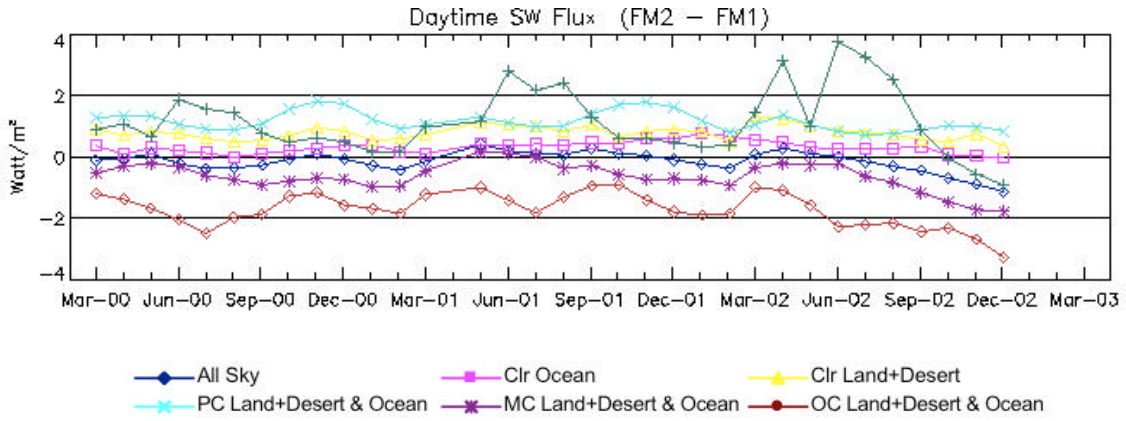
Terra Direct Comparison

SW Flux



Edition 1

Currently in Archive



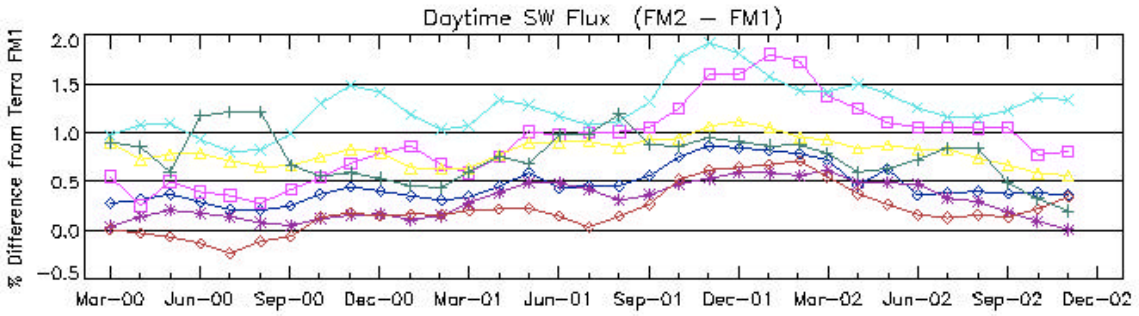
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

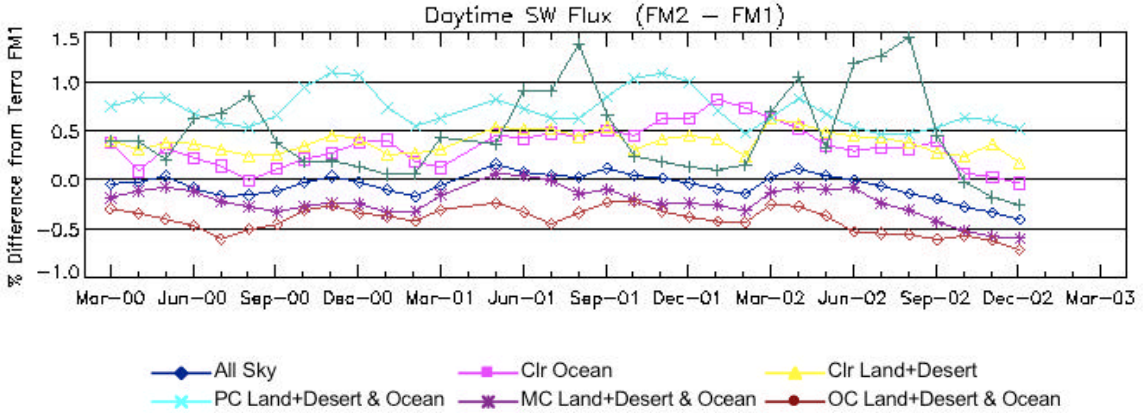
Terra Direct Comparison

SW Flux % Difference



Edition 1

Currently in Archive



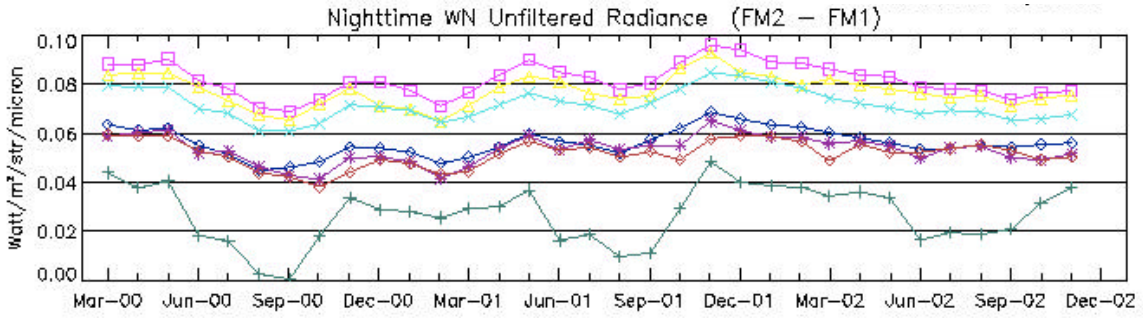
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

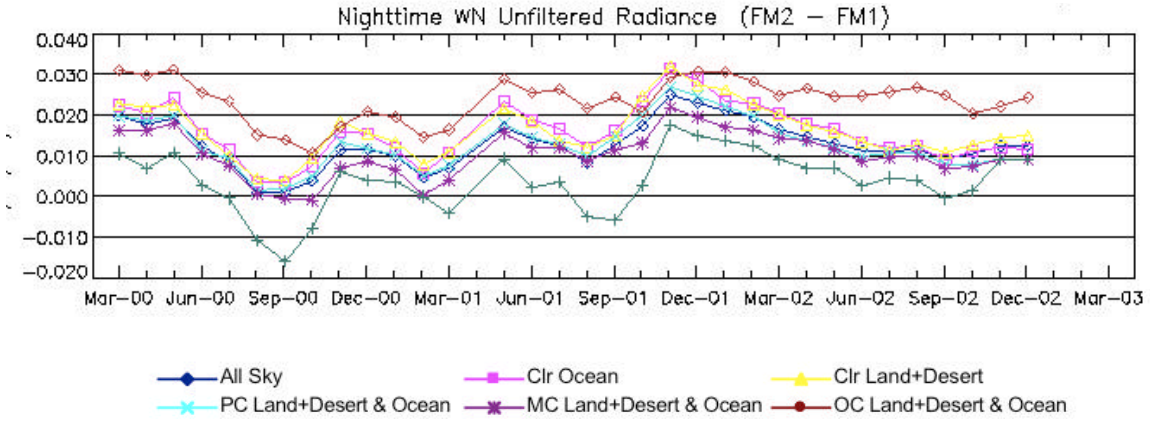
Terra Direct Comparison

Nighttime WN Radiance



Edition 1

Currently in Archive



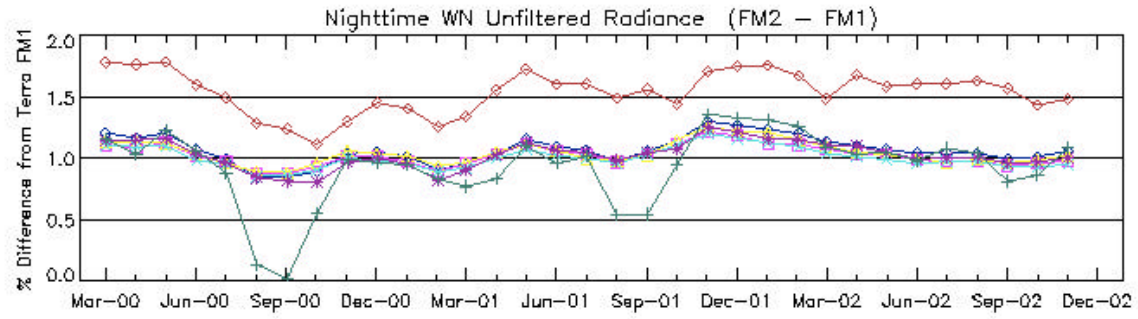
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

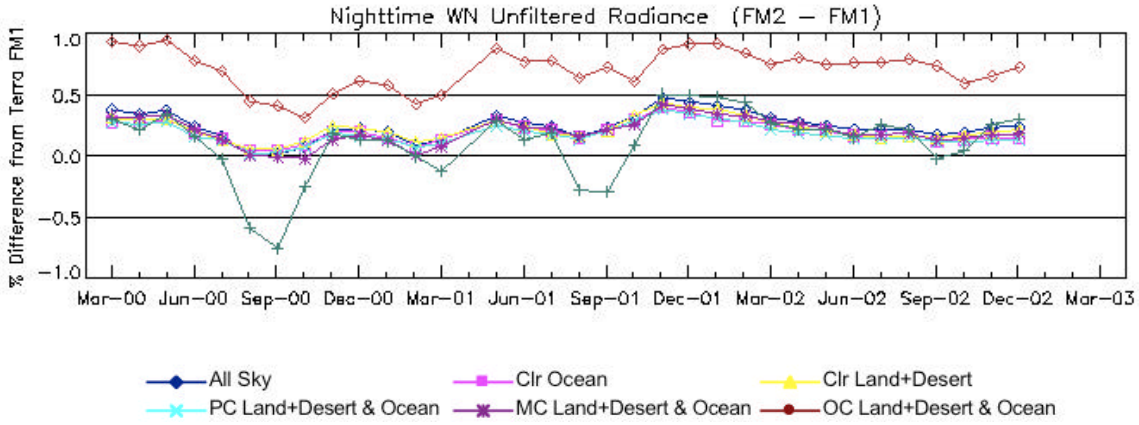
Terra Direct Comparison

Nighttime WN Radiance % Difference



Edition 1

Currently in Archive



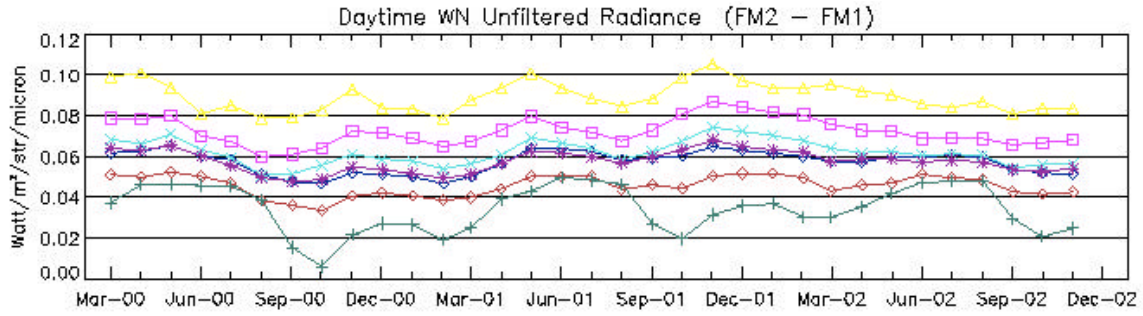
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

Terra Direct Comparison

Daytime WN Radiance



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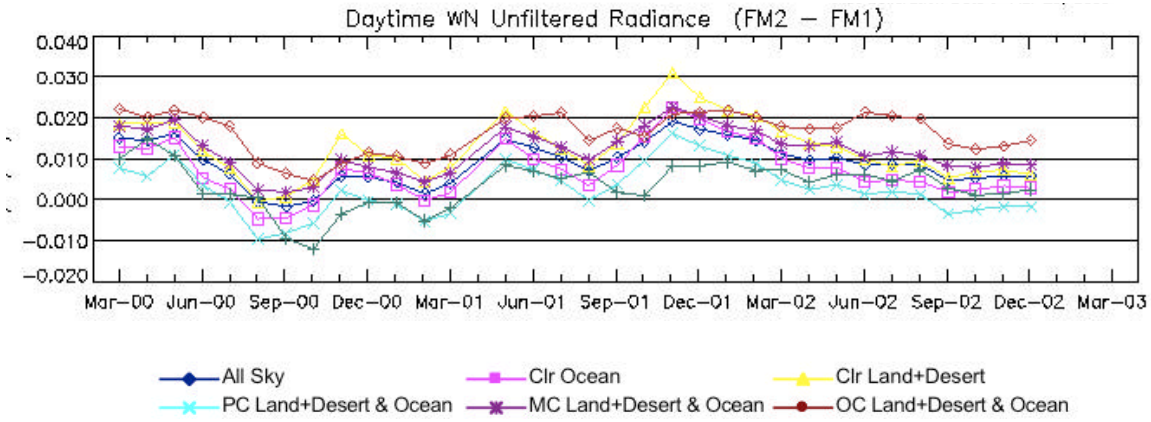


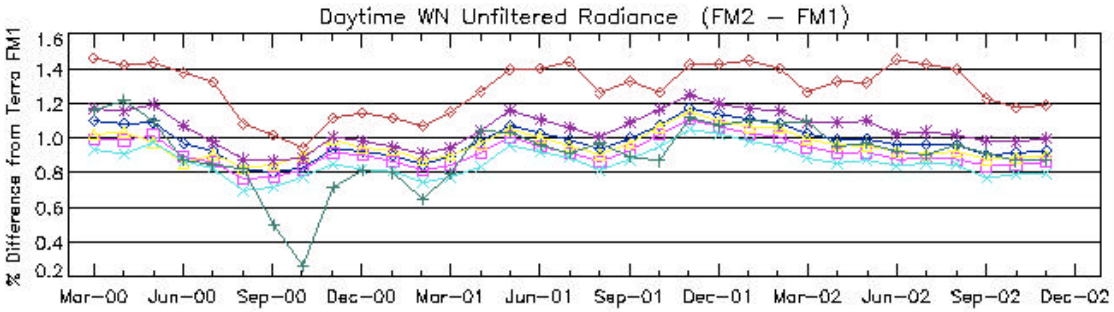
Edition 2

3/00 - 12/02 in Archive

1/03 - ??? in testing

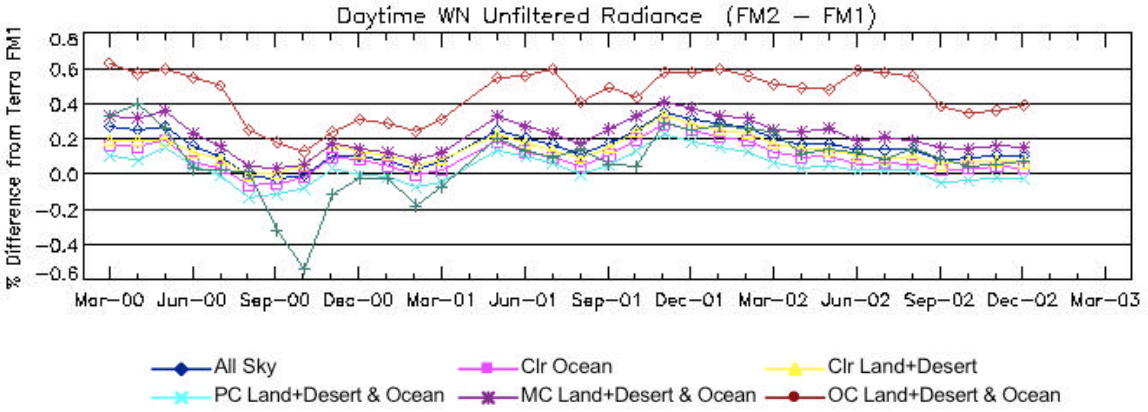
Terra Direct Comparison

Daytime WN Radiance % Difference



Edition 1

Currently in Archive



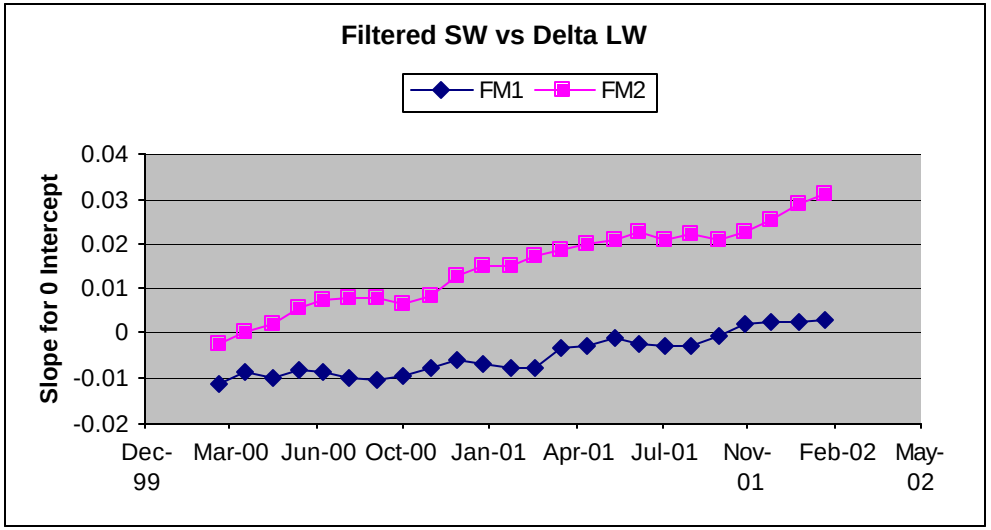
Edition 2

3/00 - 12/02 in Archive

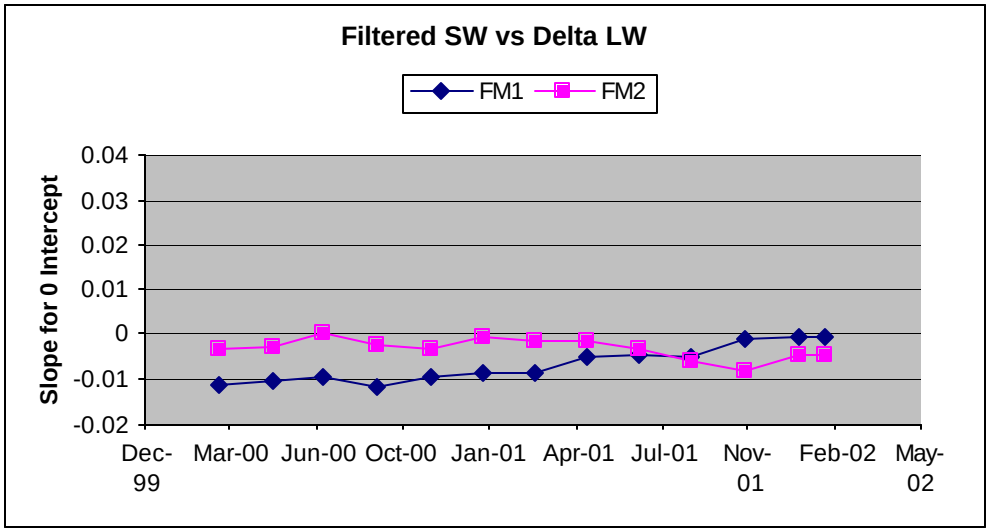
1/03 - ??? in testing

3-Channel Intercomparison

Monthly Unfiltering Error



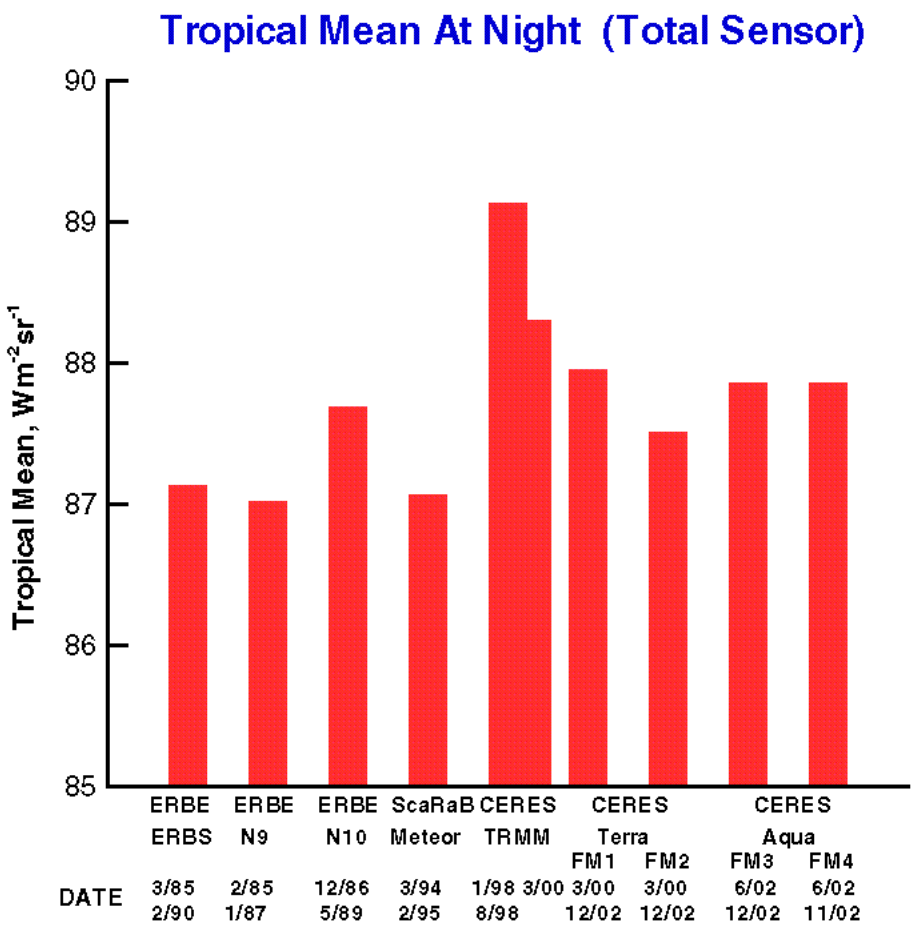
Edition 1



Edition 2

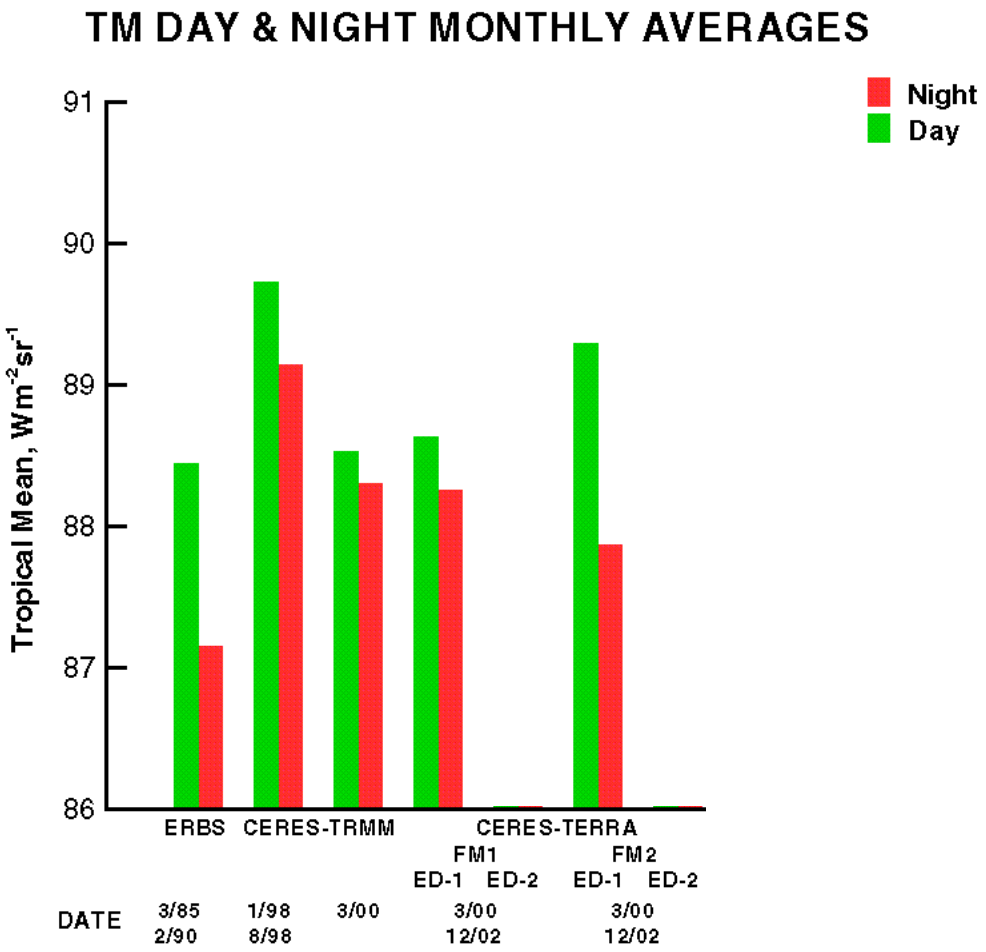
Tropical Mean Statistic

Tropical Ocean All Sky



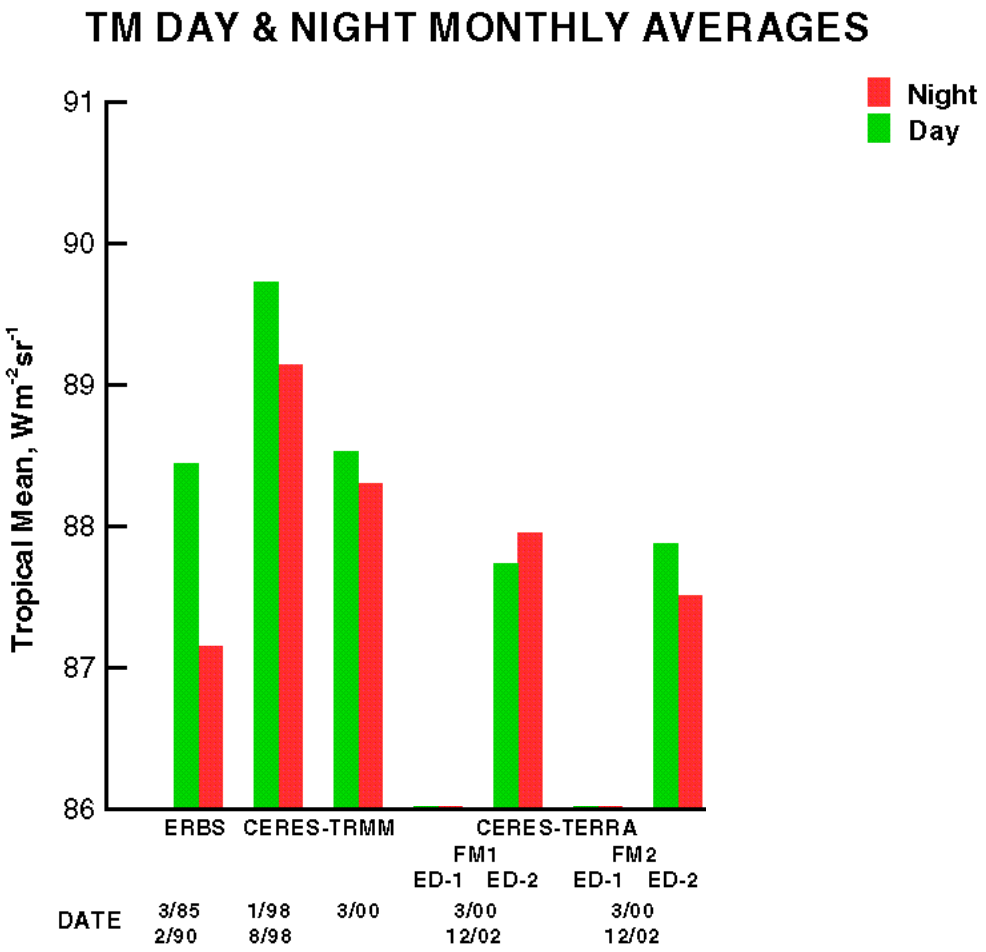
Tropical Mean Statistic

Tropical Ocean All Sky



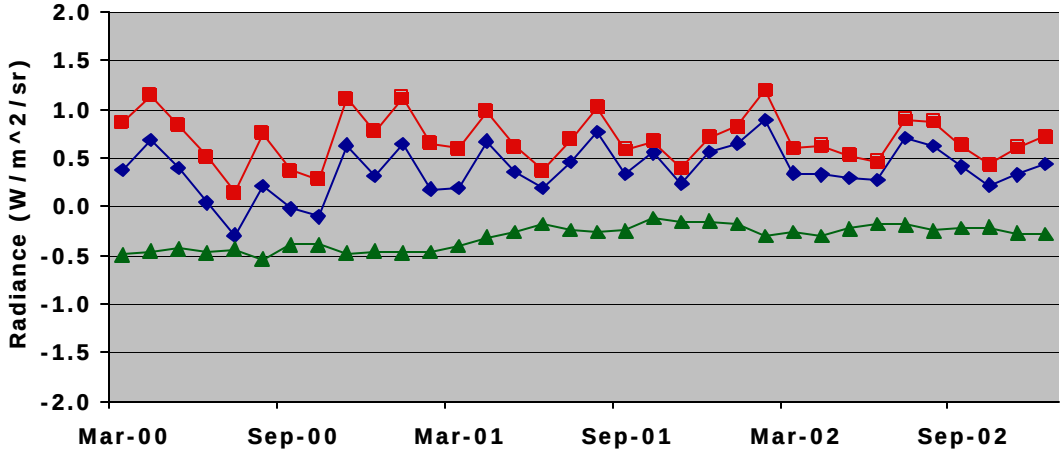
Tropical Mean Statistic

Tropical Ocean All Sky

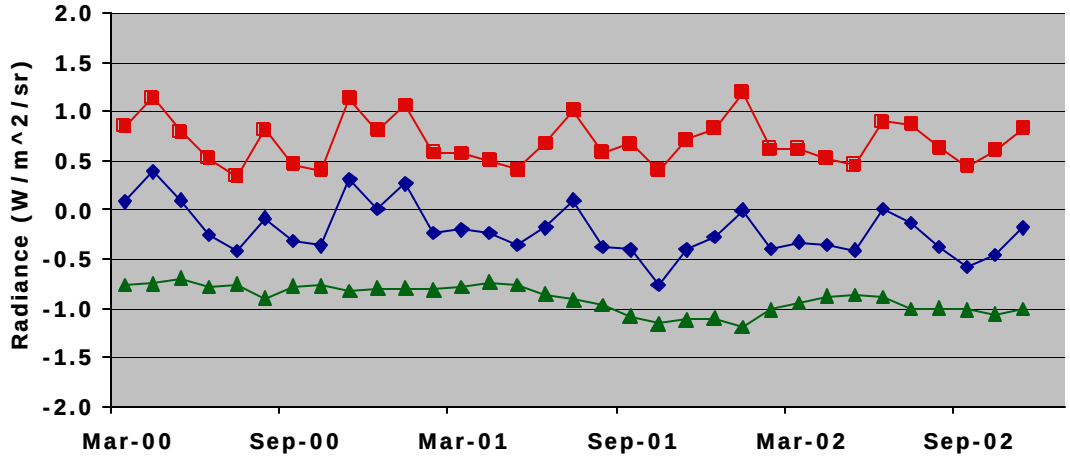


Tropical Mean Self Consistency

FM1, Tropical Ocean All Sky



Edition 1

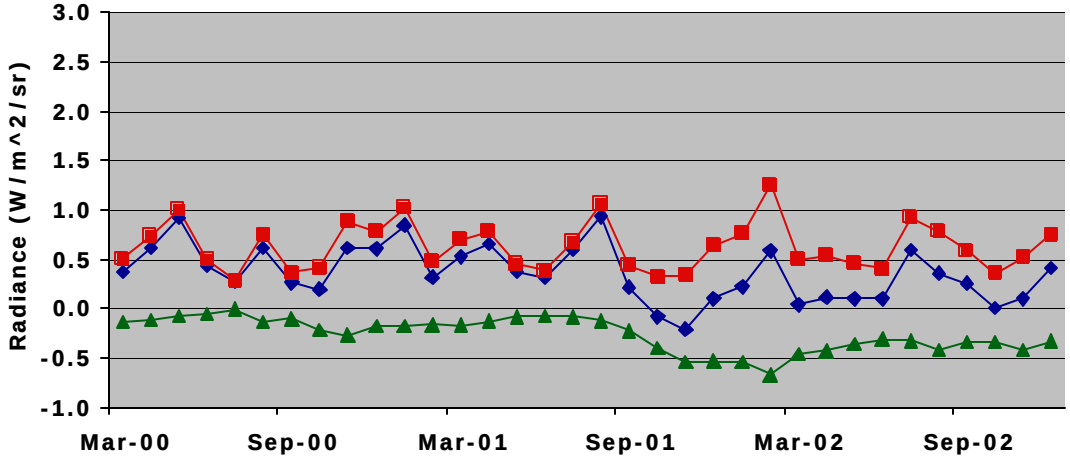


Edition 2

Tropical Mean Self Consistency

FM2, Tropical Ocean All Sky Day-Night Difference

Edition 1



Edition 2

Terra Edition 2 BDS and ERBE-Like Summary

3/00 - 2/01

Actions

Updated initial flight gains to account for shifts during launch.

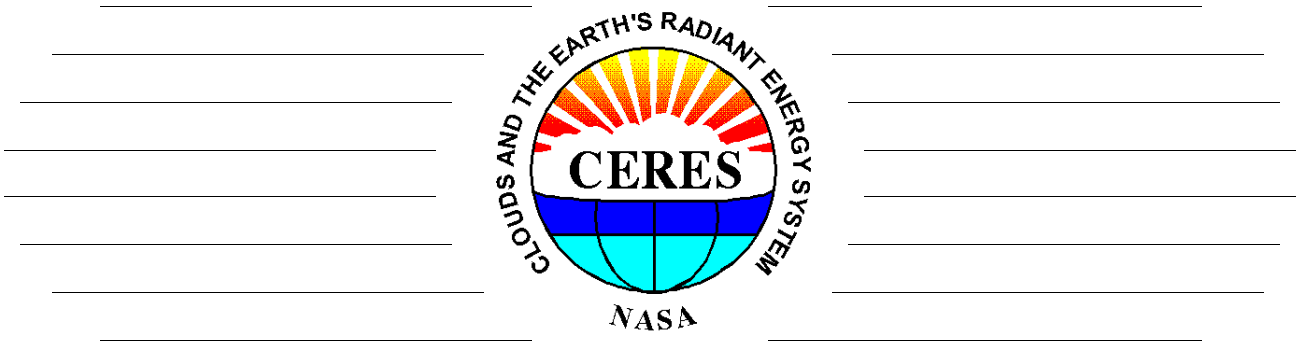
Acounted for on-orbit drifts in detector responsivites, or gains.

Accounted for changes in spectral coloration of the SW/TOT channels

Results (for All-Sky cases, 3/00 - 2/01)

		LW$_{day}$		LW$_{night}$		SW		WN$_{day}$		WN$_{night}$	
		Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1	Ed2	Ed1
Stability	**W/m^2**	**<.5**	**2.5**	**-**	**-**	**0.1**	**0.5**	**-**	**-**	**-**	**-**
	%	**<.2**	**1.0**	**-**	**-**	**<.1**	**.25**	**-**	**-**	**-**	**-**
Bias	**W/m^2**	**<1**	*******	**.5**	**.8**	**<.1**	**1.0**	**.01**	**.06**	**.01**	**.05**
	%	**<.5**	*******	**<.2**	**<.4**	**<.1**	**.25**	**0.2**	**1.0**	**0.2**	**1.0**

Aqua Status Report



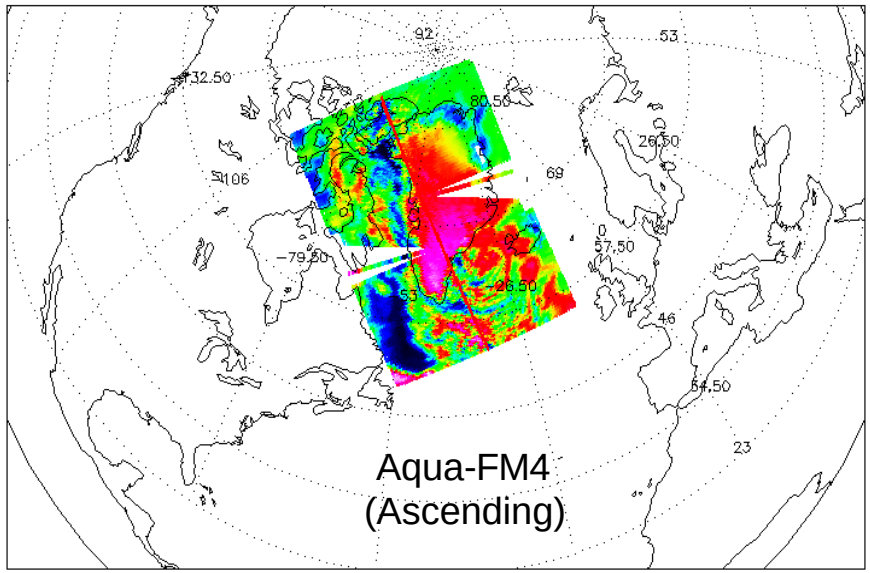
Instrument Working Group

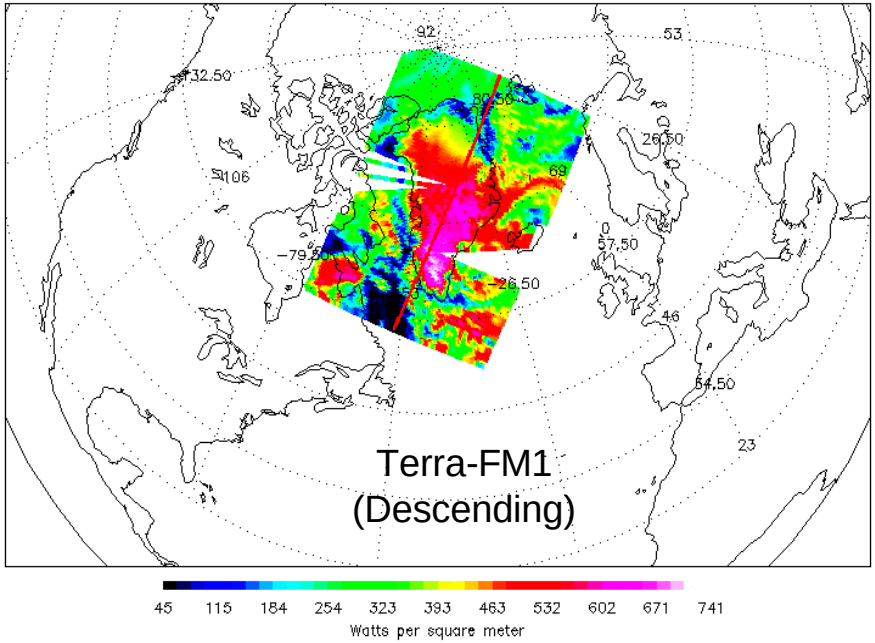
May 6, 2003

NASA Langley Research Center
Atmospheric SCIENCES

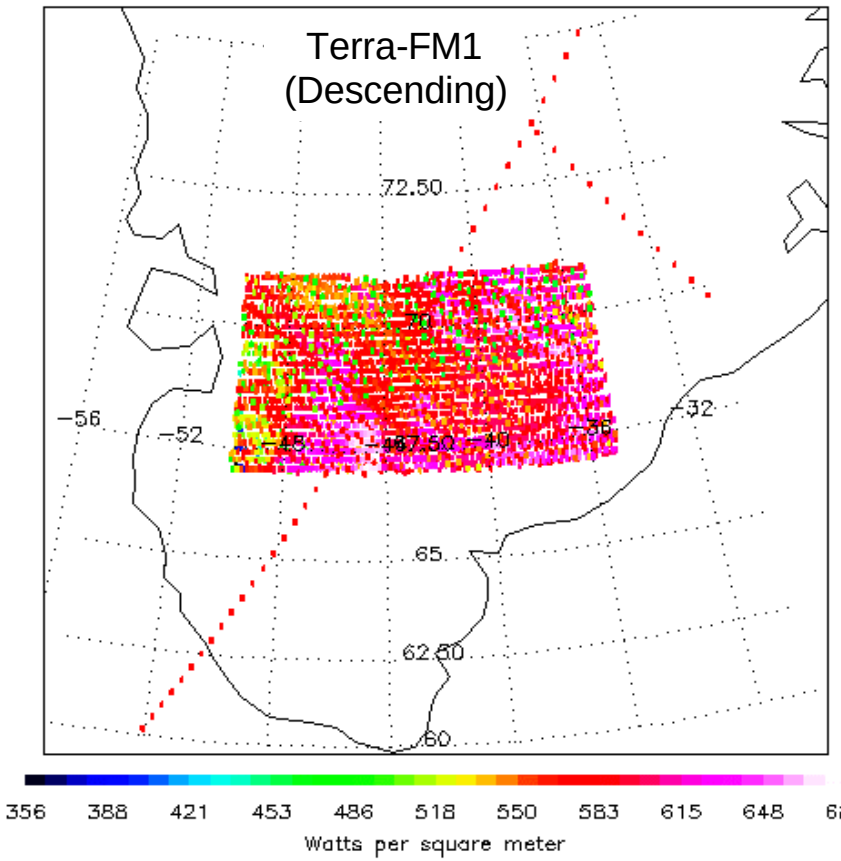
Aqua/Terra Inter-Calibration Over Greenland

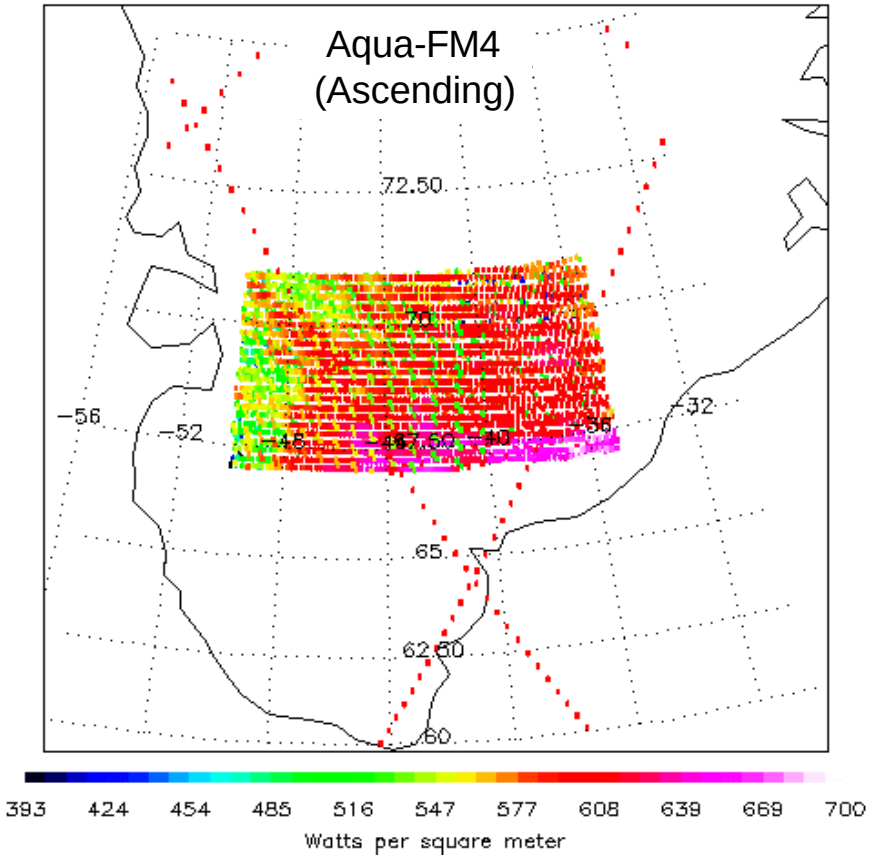
- **Orbits intersect at 69.5 deg**
- **Temporal matching <15 mins**
- **Scan planes set orthogonal to principal plane**
- **Data collected for 5-deg lat. Swath**
- **Measurements during month of July**
- **FM1 and FM4 instruments were utilized**





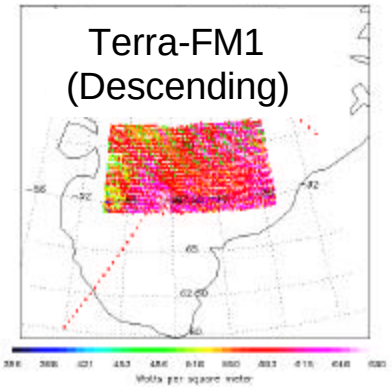
Aqua and Terra Inter-Calibration Coincident Scan Planes - Greenland

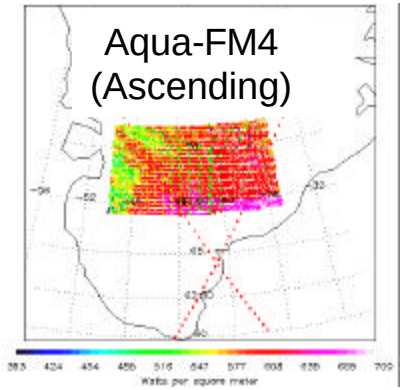




Terra/Aqua Intercalibration

FM1 and FM4 Regional (Greenland) Comparison





	Mean	St.Dev	Abs Diff	% Diff
SW	152.1	49.8	3.7 +/- 0.4	2.5
LW_{day}	83.4	5.7	8.1 +/- 0.22	9.7
WN_{day}	5.08	0.9	0.1 +/- 0.01	2.1

All units in $W/m^2/sr$ **n=271**

Diff = FM4 - FM1 **Mean = FM4**

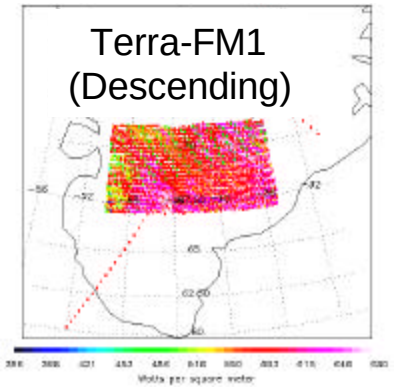
Data Products: **FM1 - Edition1 (FM1 LW_{day} is high by about 2.6 W/m^2)**

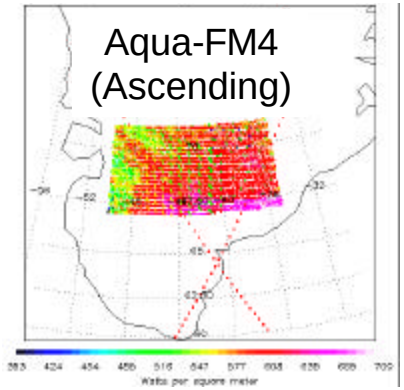
FM4 - Beta1

Conclusion: FM4 SW/TOT channel is high by 5.6%

Terra/Aqua Intercalibration

FM1 and FM4 Regional (Greenland) Comparison





	Mean	St.Dev	Abs Diff	% Diff
SW	152.1	49.8	.43 +/- 0.4	.28
LW_{day}	83.4	5.7	.38 +/- 0.22	.45
WN_{day}	5.08	0.9	0.05 +/- 0.01	1

All units in $W/m^2/sr$ **n=271**

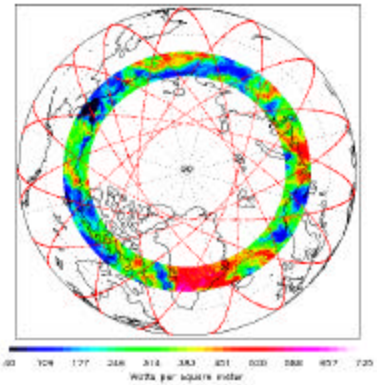
Diff = FM4 - FM1 **Mean = FM4**

Data Products: **FM1 - Edition2**

FM4 - Proposed Edition1

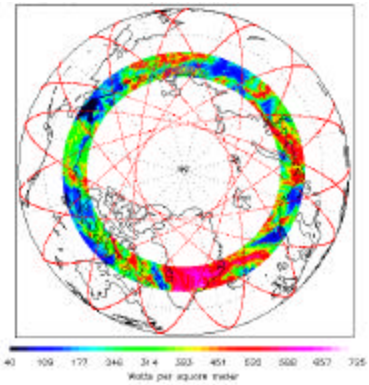
Terra/Aqua Intercalibration

FM1 and FM4 Zonal Comparison



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



	Mean	St.Dev	Abs Diff	% Diff
SW	97.1	44.9	1.7 +/- 0.1	1.6
LW_{day}	83.1	7.3	4.9 +/- 0.06	6.1
LW_{night}	55.9	6	0.1 +/- 0.02	0.2
WN_{day}	5.7	1.28	0.1 +/- 0.01	1.7
WN_{night}	3.1	.63	0.06 +/- 0.01	1.8

All units in $W/m^2/sr$ **n=5987**
Diff = FM4 - FM1 **Mean = FM4**

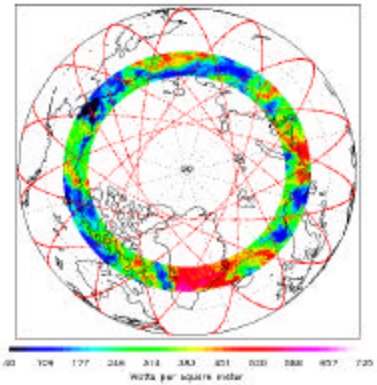
Data Products: **FM1 - Edition1 (FM1 LW_{day} is high by about 1.9 W/m^2)**

FM4 - Beta1

Conclusion: FM4 SW/TOT channel is high by 5.2%

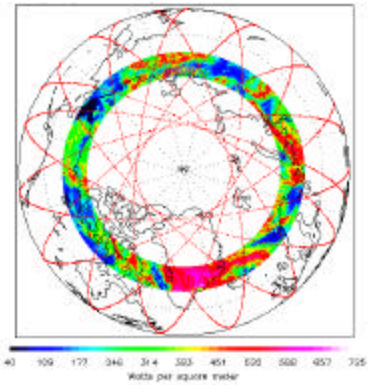
Terra/Aqua Intercalibration

FM1 and FM4 Zonal Comparison



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



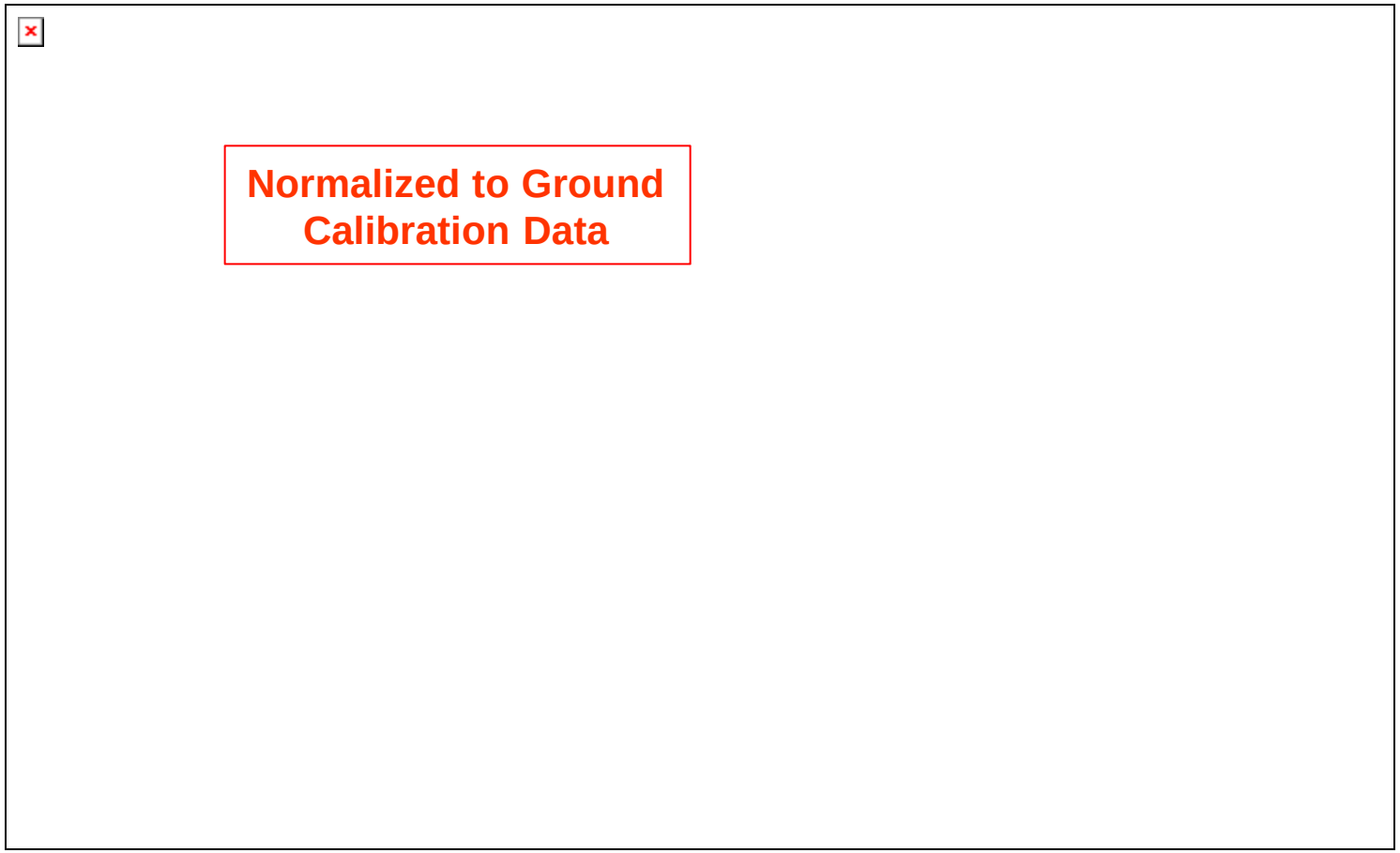
	Mean	St.Dev	Abs Diff	% Diff
SW	90.98	23.8	-0.32 +/- 0.1	-.33
LW_{day}	76.80	4.7	.52 +/- 0.06	.7
LW_{night}	55.43	4.1	0.06 +/- 0.02	.1
WN_{day}	5.53	.80	0.04 +/- 0.01	.9
WN_{night}	3.05	.40	0.03 +/- 0.01	.9

All units in $W/m^2/sr$ **n=5987**
Diff = FM4 - FM1 **Mean = FM4**

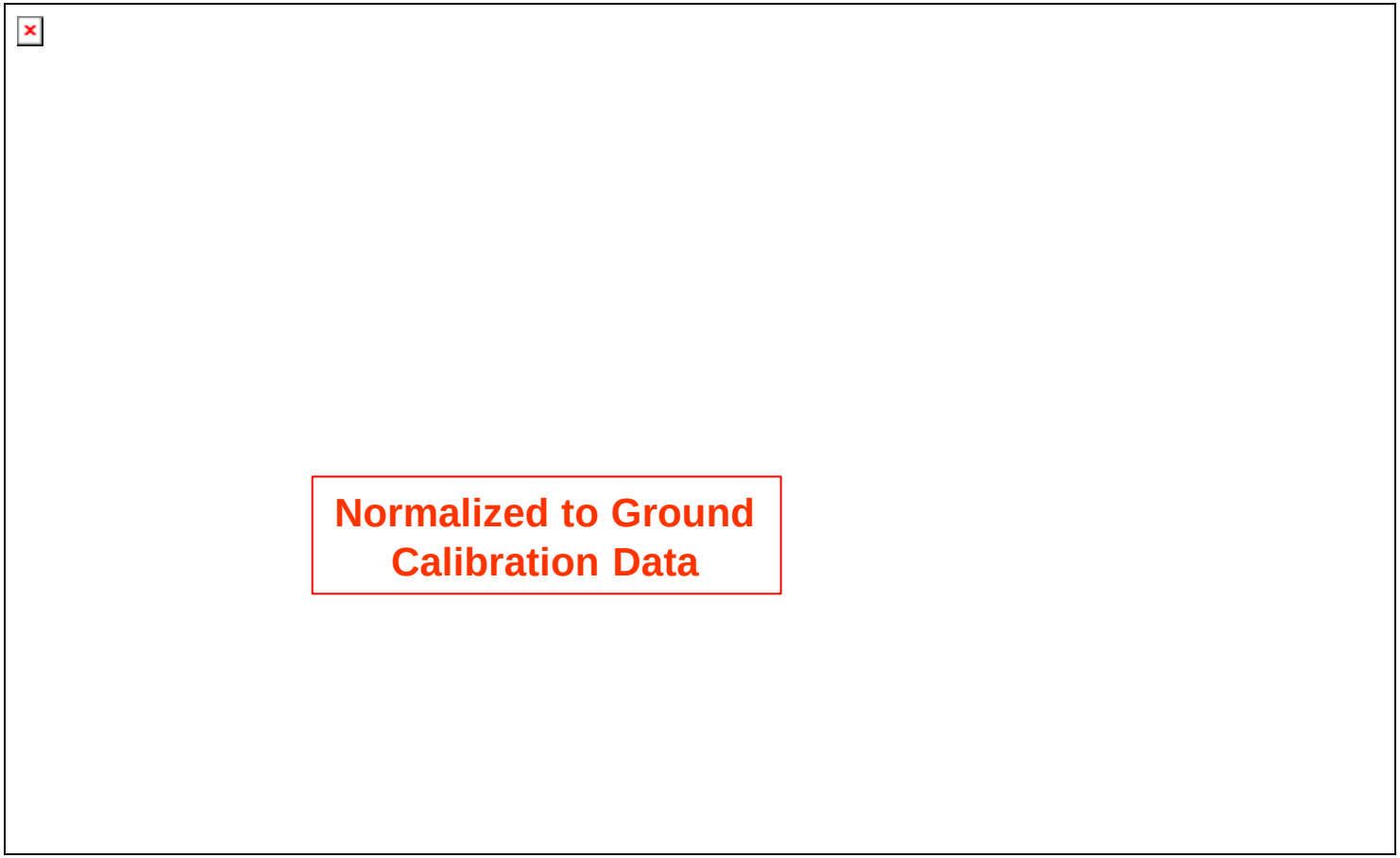
Data Products: FM1 - Edition2

FM4 - Proposed Edition1

Aqua/Flight Model 3
Lifetime Radiometric Stability
Determined with the Internal Calibration Module

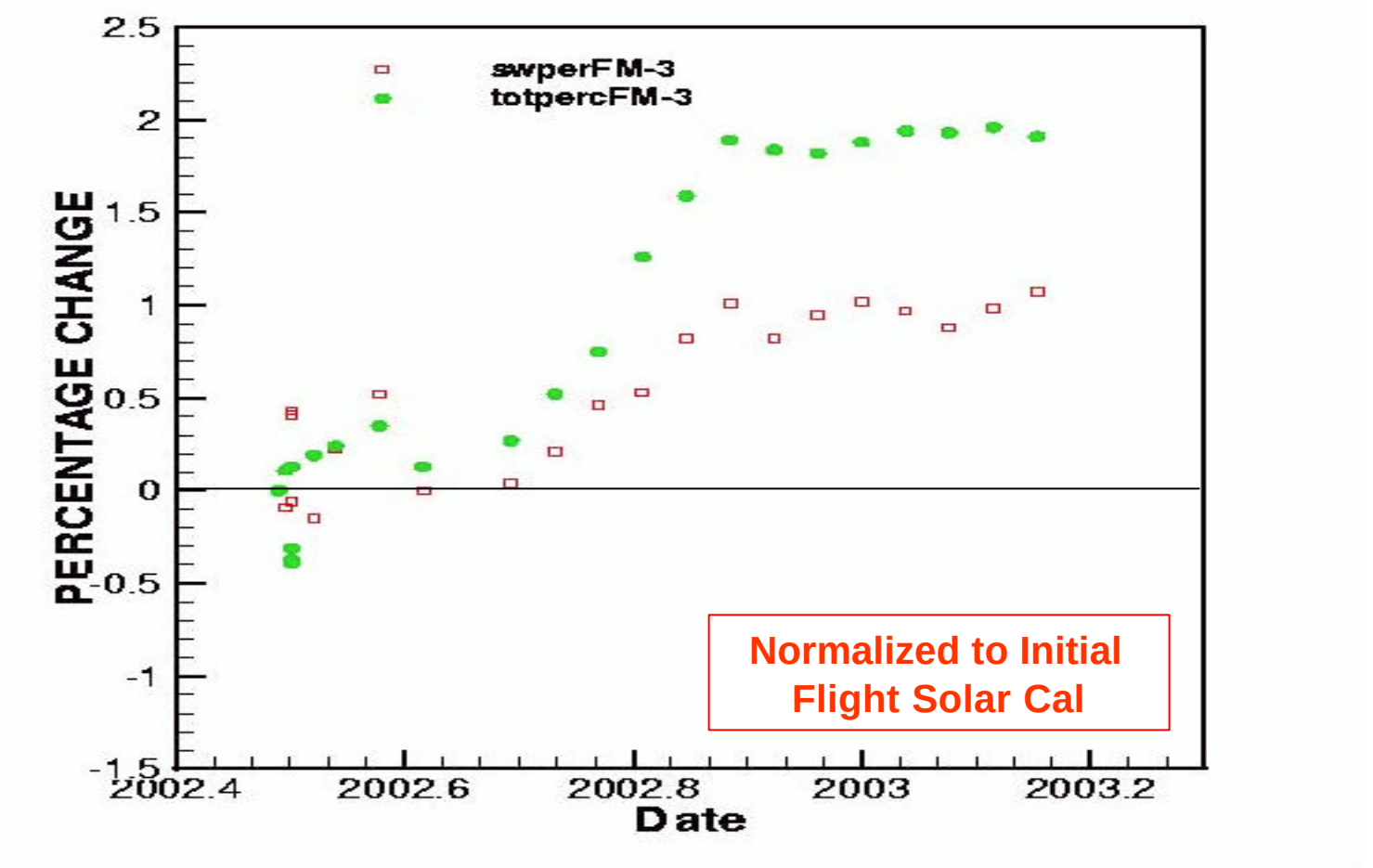


Aqua/Flight Model 4
Lifetime Radiometric Stability
Determined with the Internal Calibration Module



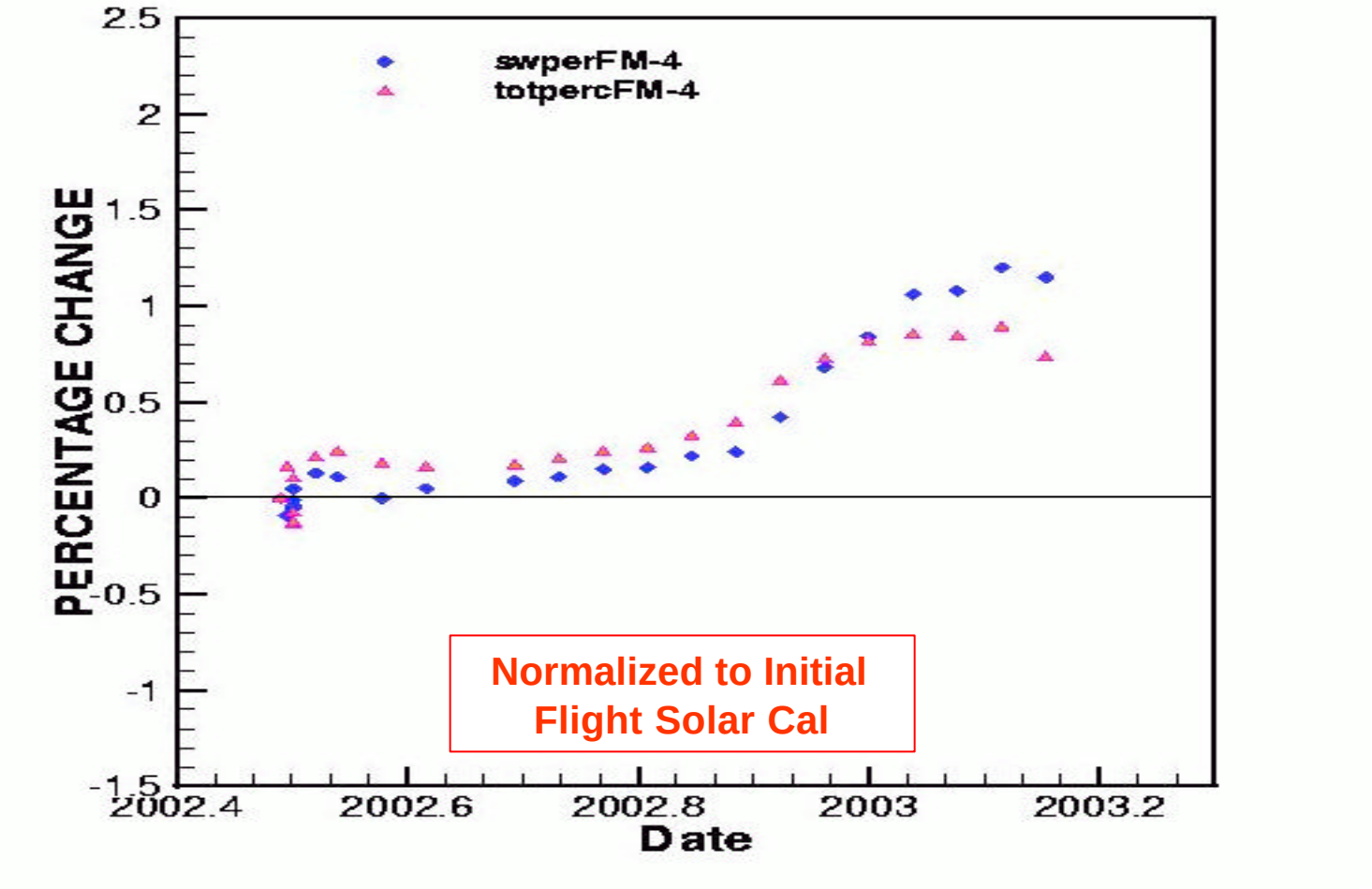
Aqua/Flight Model 3
On-Orbit Radiometric Stability

Determined with the Mirror Attenuator Mosaic (MAM)



Aqua/Flight Model 4
On-Orbit Radiometric Stability

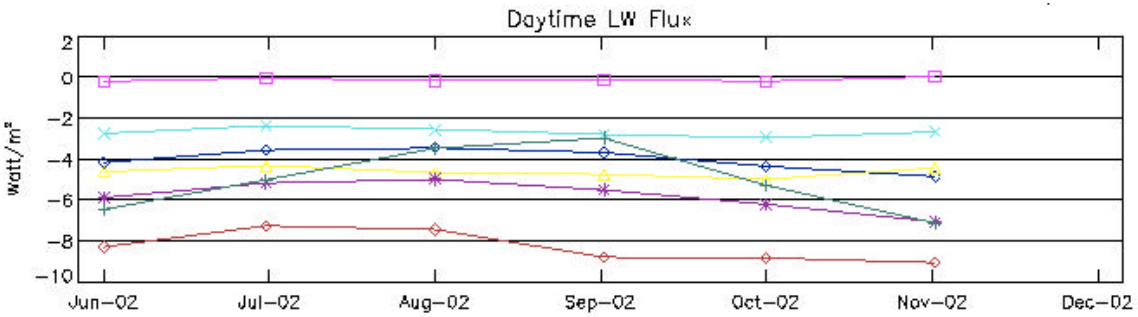
Determined with the Mirror Attenuator Mosaic (MAM)



Aqua Direct Comparison

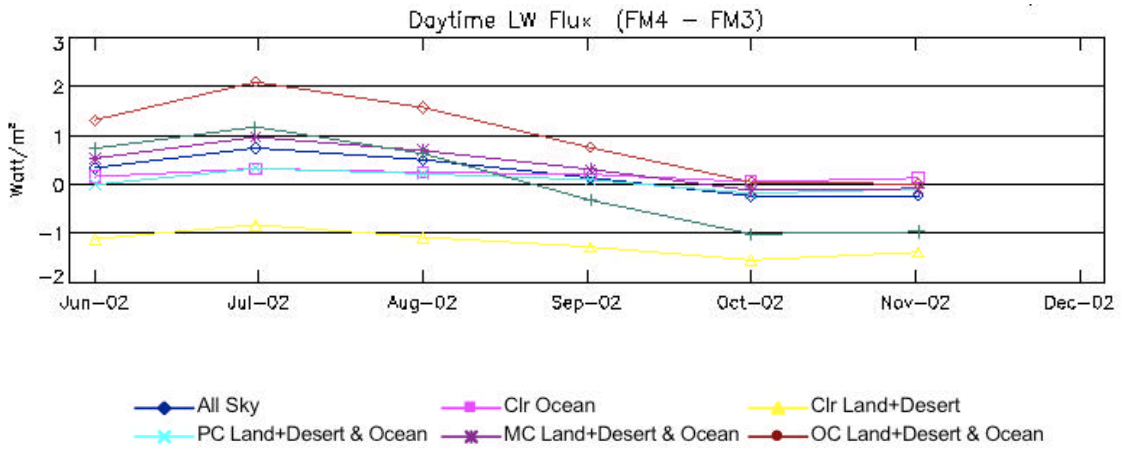
Daytime LW Flux

co-located nadir measurements



Beta1

Differences Grow with Scene brightness implying SW problem.



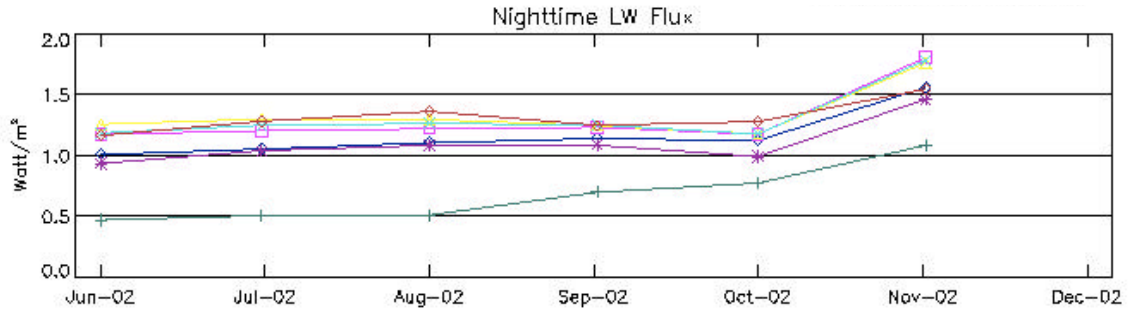
Beta2

Both FM3 and FM4 have SW/TOT errors in Beta2 which cancel

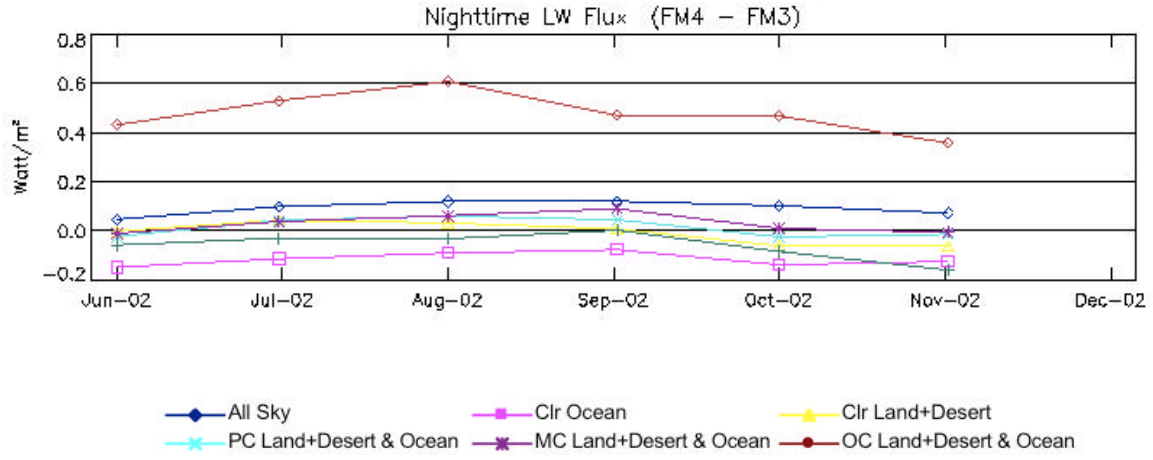
Aqua Direct Comparison

Nighttime LW Flux

Co-located nadir measurements



Beta1

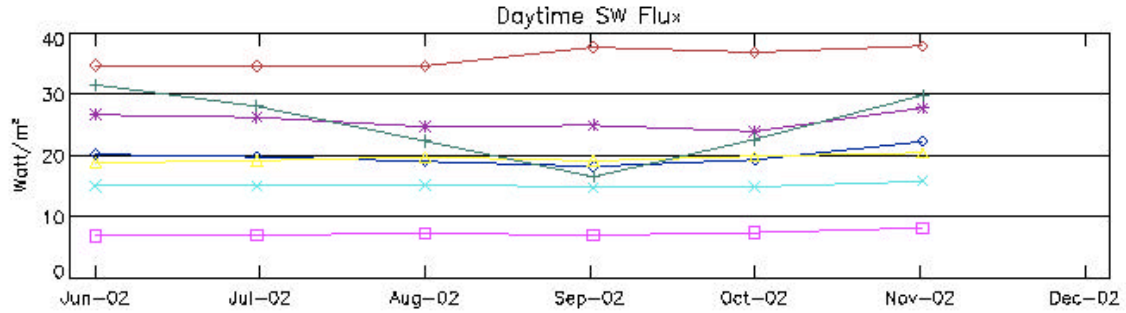


Edition1

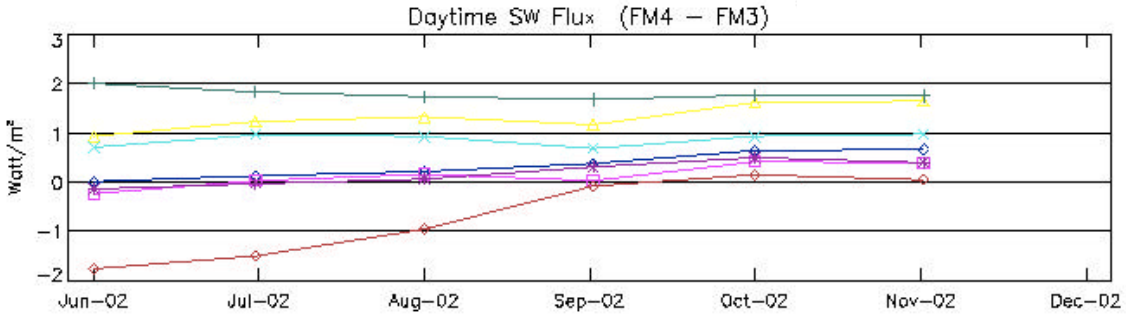
Aqua Direct Comparison

SW Flux

Co-located nadir measurements



Beta1

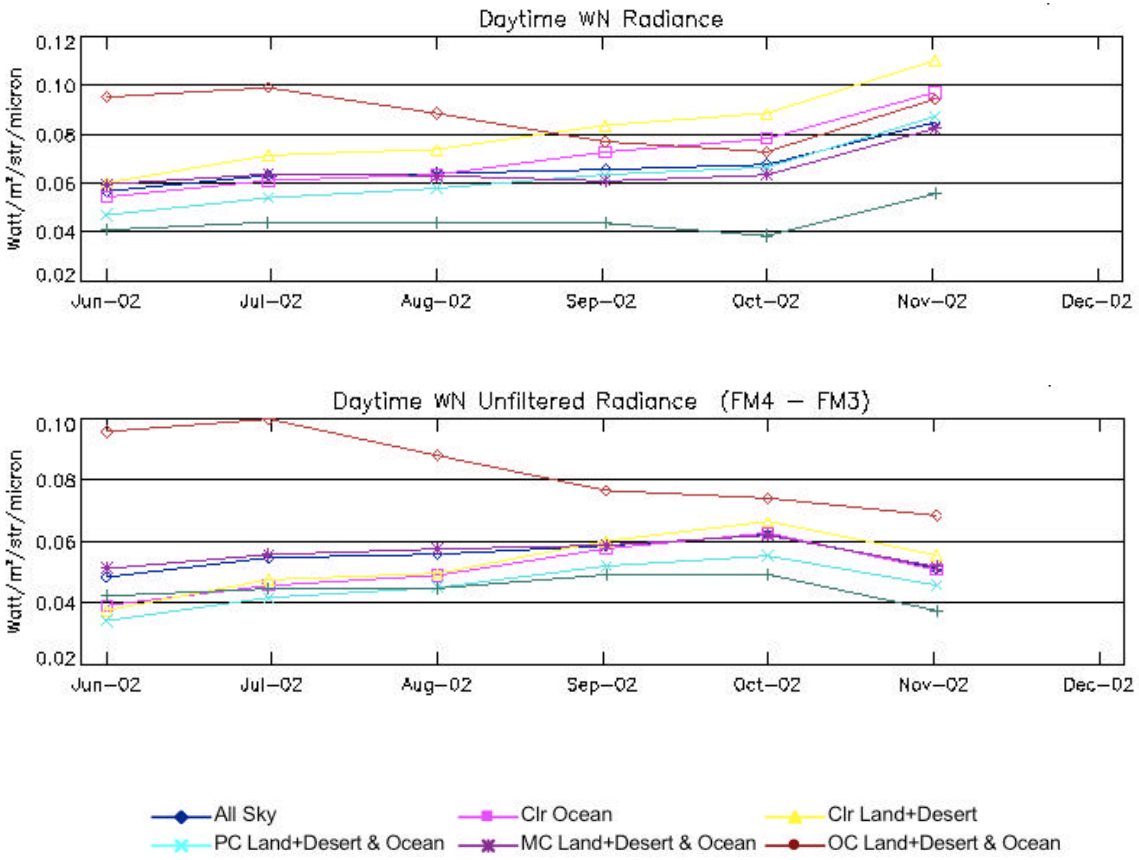


Edition1

Aqua Direct Comparison

Daytime WN Radiance

Co-located nadir measurements



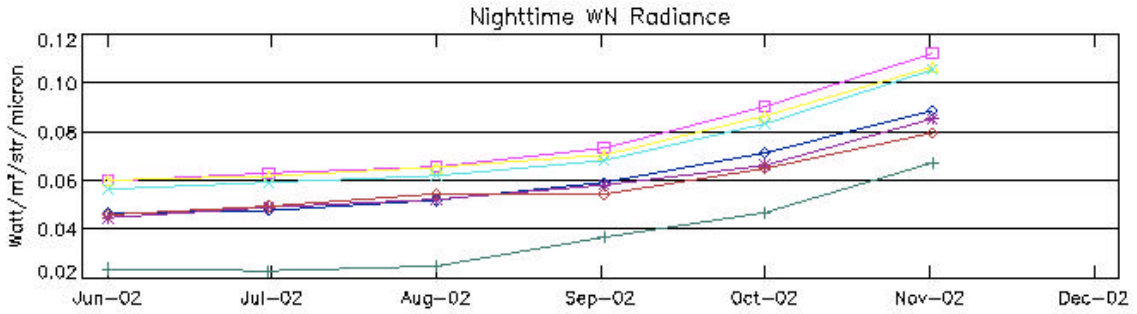
Beta1

Edition1

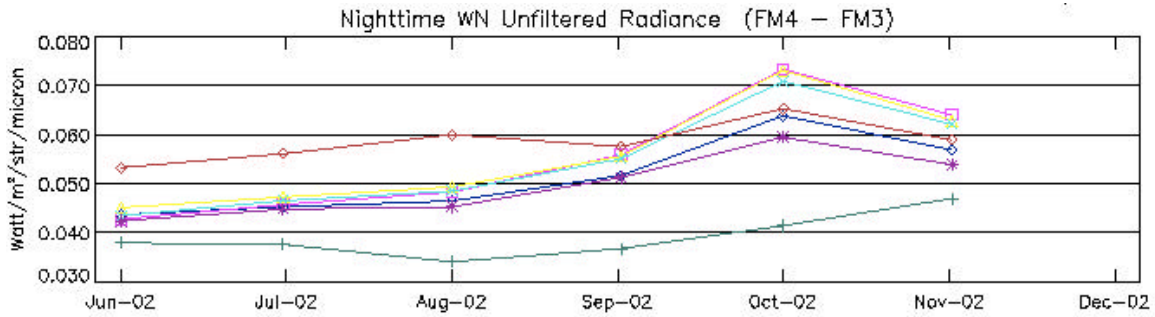
Aqua Direct Comparison

Nighttime WN Radiance

Co-located nadir measurements



Beta1

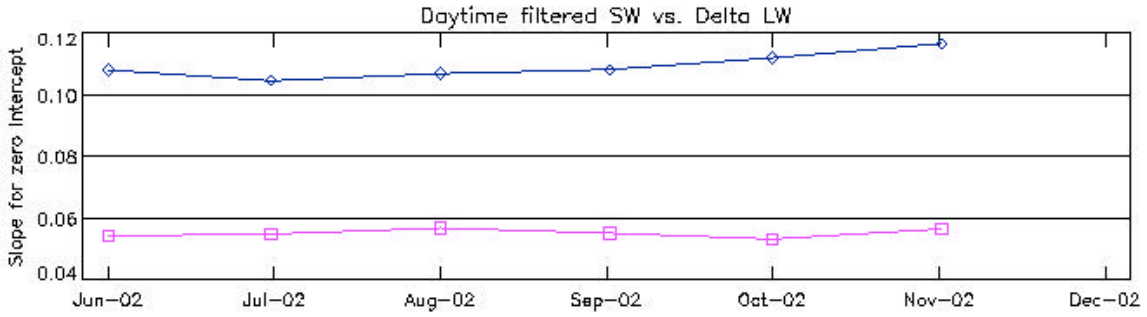


Edition1

Aqua Three Channel Inter-Comparison

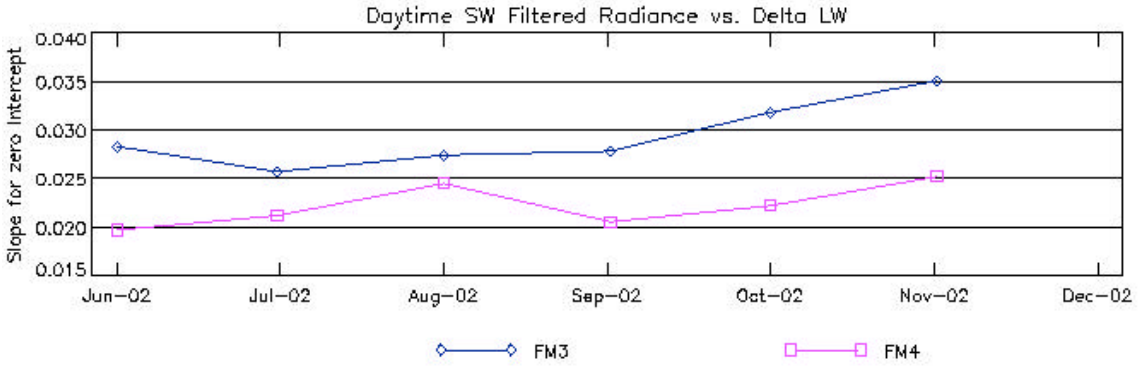
Monthly Unfiltering Error

Using Deep Convective Clouds



Beta 1

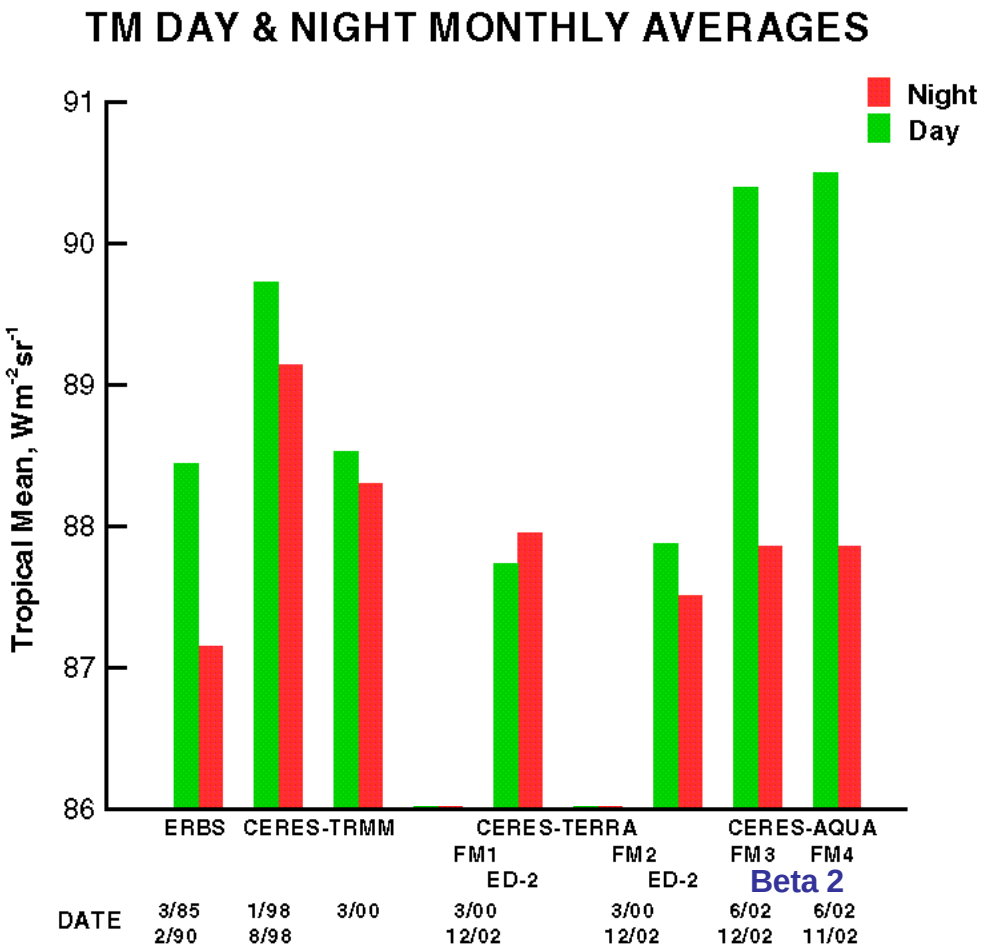
Values are consistent with those found in the TM studies.



Beta 2

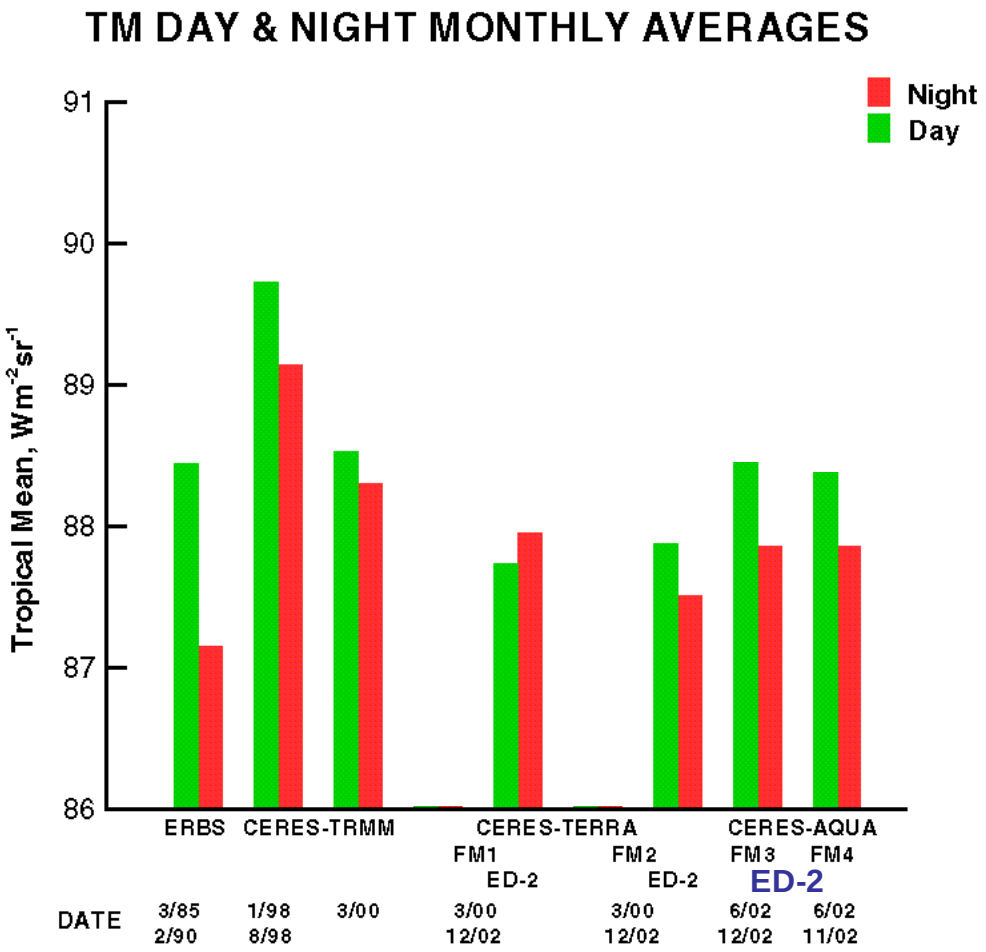
Tropical Mean Statistic

Tropical Ocean All Sky



Tropical Mean Statistic

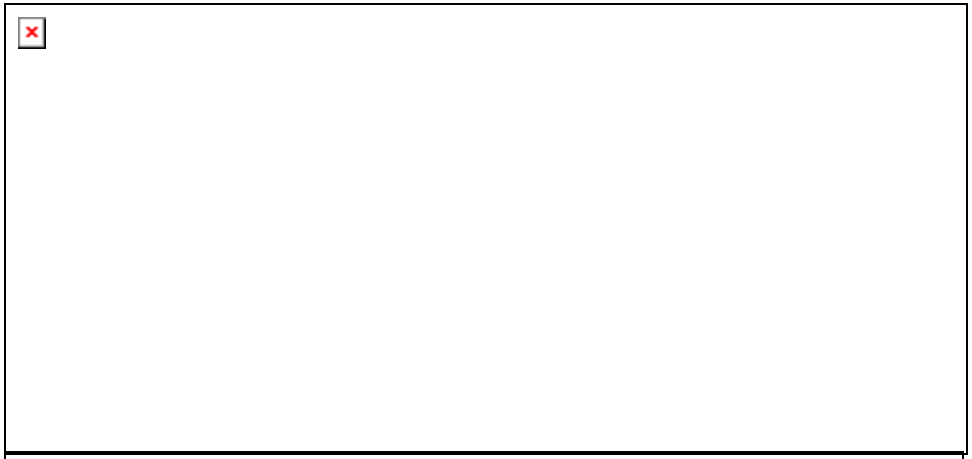
Tropical Ocean All Sky



FM3, Tropical Mean Self Consistency

Tropical Ocean, All Sky

Day-Night Differences



FM-3 Beta1

SW/TOT high by 6.3%

SW and SW/TOT disagree by 10.3%

FM-3 Beta2

SW/TOT high by 3%

FM3, Tropical Mean Self Consistency

Tropical Ocean, All Sky

Day-Night Differences

FM-4 Beta1

SW/TOT high by 5.9%
SW and SW/TOT disagree by 3.9%

FM-4 Beta2

SW/TOT high by 3%

CERES Cal/Val Summary

Terra

- Edition2 BDS and ERBE-like products available through 12/02
- Factor of 5 improvement in stability & bias for SW and LWday Ed2 products
- Unprecedented stability levels of ~0.1%/yr for CERES climate record

Aqua

- Edition1 BDS products available
- Edition1 ERBE-like products to be released by 6/03
- FM1 / FM4 intercalibrations allow Terra / Aqua instruments to be placed on same radiometric scale.
    - SW, LWnight agreement better than 0.4%
    - LWday agreement better than 0.7%
    - WN agreement better than 1.0%